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Highlights in performance science: Music performance anxiety

Edited by
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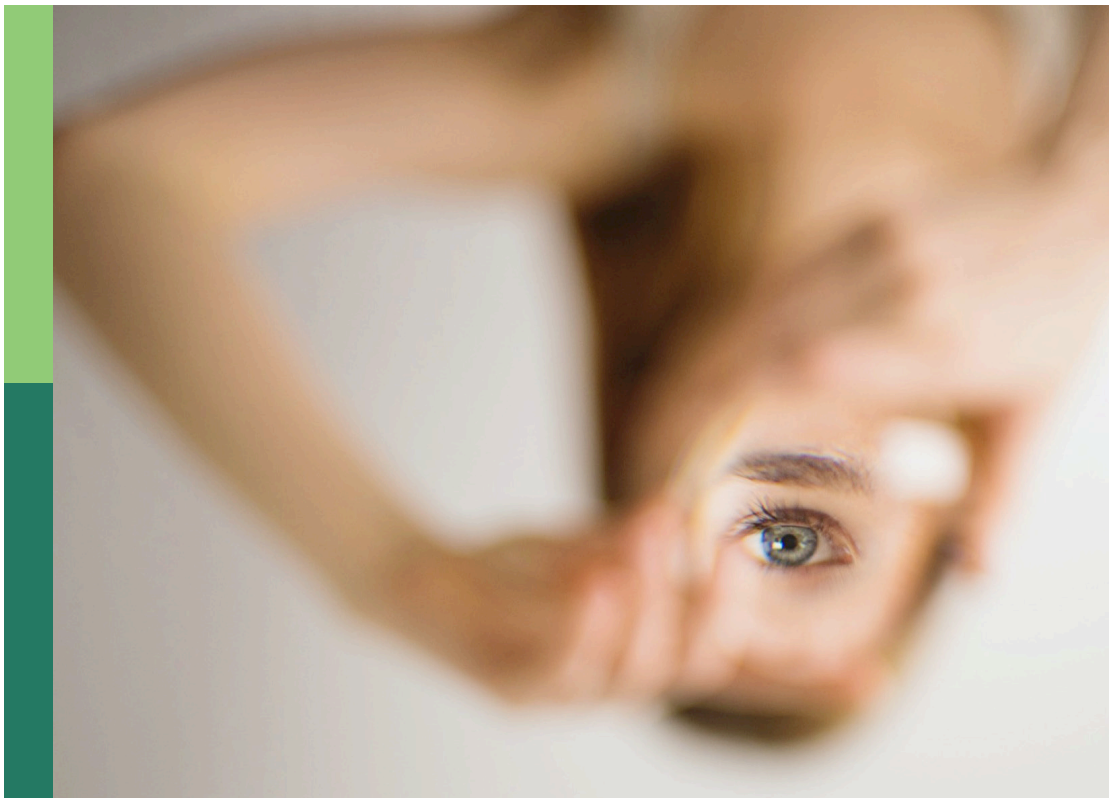

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Highlights in performance science: Music performance anxiety

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Editorial: Highlights in performance science: music performance anxiety

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Editorial on the Research Topic
Highlights in performance science: music performance anxiety

Musical performance activities are the culmination of arduous work and dedication. Musical interpretation is, at its core, an act of openness and vulnerability, which makes stage anxiety a relevant issue in the musical community. Music Performance Anxiety (MPA) is a complex and multifaceted phenomenon, manifesting in different ways and affecting musicians to varying degrees, across all educational levels and musical genres (Yoshie et al., 2009; Casanova et al., 2018; Habe et al., 2019; Guyon et al., 2020).

The Research Topic "*Highlights in performance science: music performance anxiety*" showcases a selection of articles about MPA, authored by leaders in the field. The work presented here highlights the broad diversity of research performed across the Performance Science field and put a spotlight on the main areas of interest. The Research Topic includes 14 original articles written by 41 authors from 11 countries. The articles cover many of the most relevant areas of MPA research, including its conceptualization, phenomenology, assessment, and etiology, as well as individual differences in MPA, ways of managing and coping with MPA, and the consequences of MPA. Three of the 14 contributions are review articles.

Candia et al. showed that heart rate, state anxiety, and errors rated by two experts decreased while calmness increased from the first to the third performance in 18 string players performing three times the same piece in front of different audiences of 15–20 people on the same day. There were no significant changes in self-rated valence (good-bad mood) and energetic arousal (alert-tired). The authors concluded that their findings point to the usefulness of stage training to become accustomed to realistic public self-exposure.

Chang-Arana et al. investigated the effects of pianists' trait MPA, situational stress (rehearsal vs. recital), and familiarity with the piece on listeners' perception and understanding of musical expressiveness. Their preliminary analyses with a group of 30 listeners (10 non-musicians, 10 amateur musicians, 10 semi/professional musicians) showed that perceived expressiveness was significantly affected by pianists' trait MPA and familiarity with the piece, whereas interpersonal accuracy of musical expressiveness was

significantly affected by situational stress. These findings were independent of listeners' musical background.

Starting from the observation that the prevalence of MPA has remained largely unchanged over the last 40 years, Herman and Clark reviewed the literature to identify possible reasons for the limited efficacy of current approaches to managing MPA. They synthesize and discuss a broad array of key concepts. They note that MPA is predominantly seen as a negative construct with undesirable symptoms and, accordingly, most interventions aim at managing MPA by ameliorating symptoms. They conclude that depathologizing MPA could open new perspectives and have significant practical and theoretical implications.

Irie et al. analyzed the content of reports by 38 student musicians and semi-structured interviews with eight musicians to find that the experience of mental MPA symptoms started as soon as musicians begin to prepare for public performance, the experience of physiological MPA symptoms peaked shortly before public performance, and the experience of behavioral MPA symptoms peaked during public performance. To deal with these different symptoms, musicians reported to use specific strategies such as positive self-talk, concentration, and deep breathing.

The Kenny Music Performance Anxiety Inventory (K-MPAI) is one of the most widely used questionnaires to assess MPA. In her review article, Kenny, the creator of this instrument, examines the research that has used the K-MPAI and touches on a number of important related topics and constructs such as cross-cultural validation, theoretical and clinical conceptualizations of MPA, depression, low self-esteem, somatization, performance quality, and the idiosyncratic nature of MPA in each musician.

Kirsner et al. take a lifespan perspective on MPA by investigating the potential impact of caregiver experiences and patterns of dysfunctional cognitive schemas during childhood and adolescence on the manifestation and severity of MPA in adulthood. Combining data from a survey with 100 musicians and from interviews with eight musicians, these authors show that high-anxious and low-anxious musicians differed in numerous childhood experiences with their parents and in the development of cognitive schemas related to the themes of failure, catastrophizing, and incompetence/dependence.

Choking under pressure refers to performing worse than expected despite high skills and motivation to perform well. In their study, Lubert et al. investigated the effects of a 10-week psychological chocking intervention comprising acclimatization training, goal setting, imagery, self-talk, and relaxation techniques in six musicians, two dancers and one actress. Their mixed-methods analysis revealed reduction in performance anxiety and fear of negative evaluation, and improved self-efficacy and performance quality.

In their PRISMA-based systematic review article, Mazzarolo et al. explored the strategies that music educators use to help manage their students' MPA and teacher and student perceptions of teachers' role in MPA management. The nine articles included in the review indicate that the most common strategies are simulated performance, positive outlook, preparation, and breathing. Most of these strategies are not specifically employed by the educators to influence MPA; rather, they are part of their regular teaching practice. Most students would like to receive support both from their teachers and experts.

Moral-Bofill et al. investigated the effects of a 12-week electronic intervention program called Self-Regulation Skills for Performing Musicians on flow experience (defined in terms of the six dimensions action-awareness merging, concentration on task, sense of control, loss of self-consciousness, transformation of time, and autotelic experience), MPA and social skills. Compared to a control group, the experimental group reported a significant improvement in flow experience (mainly in sense of control and loss of self-consciousness) and MPA from pre- to post-intervention.

Passarotto et al. investigated the relationship between MPA, practice behaviors (practice time and number of repetitions), and performance quality by monitoring 30 healthy pianists practicing a short musical excerpt. State anxiety correlated positively with practice time and number of repetitions, which the authors interpreted as supporting the hypothesis that more anxious musicians are at higher risk of developing playing-related injuries as a result of overuse and repetitive strain. Pianists who improved their playing were also less anxious in the latter part of the experiment.

Rosset et al. conducted a comprehensive health-related survey among 205 university first-year music students at the beginning of their first semester and 62 students at the end of their second semester. On average, mental health was good at the start of the first year but decreased at the end of the second semester. The article highlights differences between performance majors and music education majors in health-related knowledge and coping abilities and between instrument types in practice time and bodily pain. Moreover, students attending courses on musicians' health improved their knowledge about health risks.

In a sample of 186 university-level classical music students, Sokoli et al. found that students' age, gender, and instrument were significant predictors of their pre-performance affective, cognitive, and somatic experience. The study further found that worsening in performance quality from practice to public performance was reported by almost half of the students and best predicted by pre-performance anxious feelings and breathing-related complaints. The authors suggested that the assessment of MPA could be refined by better taking into account instrument specific performance-related bodily complaints.

Spahn et al. assessed dispositional MPA and state MPA during a concert among 67 young amateur musicians of a brass choir. In line with previous classifications, the authors identified three types of MPA with about 75% of the musicians being assigned to the positive type characterized by low levels of MPA symptoms and high levels of self-efficacy and positive functional coping. The article also provided an analysis of the degree of correlation between dispositional MPA and state MPA.

Yao and Li investigated to what extent the Individual Zone of Optimal Functioning model can help predict performance quality using the three anxiety dimensions somatic anxiety, cognitive anxiety, and self-confidence among 30 college-level piano-major students. The study highlighted the strengths and limitations of this model, the idiosyncratic nature of the relationship between self-perceived anxiety and expert-rated performance quality, as well as important directions for future research in this area.

In conclusion, the articles of this Research Topic greatly contribute to the advancement of our understanding of MPA and its role and implications for musicians' wellbeing, health, and career. They also show avenues and opportunities for further developments, demonstrating that MPA remains a highly relevant topic for research and practice in performance science.

Author contributions

PG: Writing – original draft. OC: Writing – review & editing. KH: Writing – review & editing. MY: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Casanova, O., Zarza, F. J., and Orejudo, S. (2018). Differences in performance anxiety levels among advanced conservatory students in Spain, according to type of instrument and academic year of enrolment. *Music Educ.Res.* 20, 377–389. doi: 10.1080/14613808.2018.1433145

Guyon, A. J. A. A., Studer, R. K., Hildebrandt, H., Horsch, A., Nater, U. M., and Gomez, P. (2020). Music performance anxiety from the challenge and threat perspective: psychophysiological and performance outcomes. *BMC Psychol.* 8, 87. doi: 10.1186/s40359-020-00448-8

Habe, K., Biasutti, M., and Kajtna, T. (2019). Flow and satisfaction with life in elite musicians and top athletes. *Front. Psychol.* 10, 698. doi: 10.3389/fpsyg.2019.00698

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

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ORIGINAL RESEARCH
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Preliminary Assessment of Individual Zone of Optimal Functioning Model Applied to Music Performance Anxiety in College Piano Majors

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Individual zone of optimal functioning (IZOF) is a psychological model studied and applied to quantify athletes' anxiety and predicts their achievement in sports competitions. This study aimed to determine the application of the IZOF model to evaluate music performance anxiety (MPA) in pianists because the causes of anxiety in athletes and musicians may be similar. A total of 30 college-level piano-major students were included in the study, and the anxiety level in performance was scored by the Competitive State Anxiety Inventory-2 questionnaire. In the first phase, participants recalled and self-scored the four important performances in the past year. Notably, seven piano teachers scored the performances. Both results were combined to identify the individual IZOF zone. Each student showed different anxiety scores for cognitive state anxiety (CA), somatic state anxiety (SA), and self-confidence (SC). In the second phase, all participants scored their anxiety level 1 day before the final performance, and the same judges evaluated the performance immediately afterward. A total of 60% of the participants who had at least two subscales inside the IZOF received performance scores greater than 90. In conclusion, the IZOF model provides information for both piano teachers and pianists to help review their anxiety intensity and predict their performance scores to some extent.

Keywords: music performance anxiety, IZOF model, optimal performance, performance predicting, cognitive state anxiety (CA)

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INTRODUCTION

Research on music performance anxiety (MPA) has been conducted for several decades and is still ongoing (Fishbein et al., 1988; Steptoe, 2001; Kenny and Osborne, 2006; Kenny, 2011; Topoğlu, 2014; Guyon et al., 2020b). MPA is a globally negative and debilitating psychological phenomenon in musicians regardless of age, gender, experience, practicing time, and music genre (Brugués, 2011a,b; Studer et al., 2011; Barbar et al., 2014; Nusseck et al., 2015; Bannai et al., 2016; Sousa et al., 2016; van Fenema et al., 2017; Burin et al., 2019; Guyon et al., 2020a). MPA had been identified in music students and shown statistically significant differences in various psychological constructs, including optimism, self-efficacy, achievement motivation, and sensitivity to reward and punishment (Alzugaray et al., 2016). A significant relationship was reported between the age of

starting musical training and the individual's current perceived level of MPA; students who started at the age of 7 or younger showed lower levels of MPA (Zarza-Alzugaray et al., 2018). Furthermore, the MPA level increased among advanced conservatory students during their 4-year university-level studies (Casanova et al., 2018). A previous study revealed that 33.9% of participants had used substances to cope with MPA, and more than half of them had considered abandoning their musical studies. Participants who used substances had more frequent thoughts of giving up their musical career and had a higher level of MPA than control students (Orejudo Hernández et al., 2018). The relevance of family support for self-efficacy in public performance was mediated through MPA directly and showed consequent differences between genders (Zarza-Alzugaray et al., 2020). Social supports, such as the role of parents, teachers, and peers, were crucial for predicting self-efficacy for learning in students from advanced music schools (Orejudo et al., 2021). Nevertheless, MPA is a validated construct that can harm musicians' performance quality and their careers (Osborne and Kenny, 2005; Yoshie et al., 2009; Davison, 2020).

Musicians may be ashamed to admit that they are suffering from performance anxiety (Bodner and Bensimon, 2008; Brugués, 2009). However, performance anxiety represented a series of psychosomatic manifestations and was a furtive concept for musicians, causing doubt about their performance quality (Lee, 1988). In addition, music educators had often consciously avoided this issue in their teaching process since anxiety management was typically beyond their training, talent, practice, experience, and dedication (Nideffer and Hessler, 1978).

Numerous strategies have been presented in previous studies and were shown to be widely used to control and improve the physical responses to MPA, including music-assisted progressive muscle relaxation, relaxation breathing training, yoga, physical activity, improvisation-assisted desensitization, psychoanalytic and cognitive-behavioral therapies, imagery-based interventions, acceptance and commitment therapy, music performance skills course, oxytocin intake, and expressive writing intervention (Kim, 2008; Su et al., 2010; Khalsa et al., 2013; Rocha et al., 2014; Studer et al., 2014; Spahn, 2015; Finch and Moscovitch, 2016; Kenny et al., 2016; Juncos et al., 2017; Cohen and Bodner, 2018; Fernholz et al., 2019; Zhukov, 2019; Clarke et al., 2020; Sabino et al., 2020; Shaw et al., 2020; Tang and Ryan, 2020).

Anxiety was thought to have both facilitated and attenuated individuals' performances (Burton and Naylor, 1997). Performers with facilitative anxiety often described it as excitement, being pumped, or being "in the zone," and they did not seek help from psychologists or other treatment professionals for assistance to reduce their anxiety (Lehrer et al., 1990; Robertson and Eisensmith, 2010). Wolfe also noted that MPA had positive effects on performance and explained these as an adaptive component of MPA (Wolfe, 1989). The adaptive component, also known as functional anxiety, readied the performer for the challenge ahead by directing preparatory arousal into practical task-oriented actions (Mor et al., 1995). Therefore, anxiety reduction may not be the most appropriate strategy for intervention to manage performance anxiety and achieve peak performance (Chamberlain and Hale, 2007). Increasing clinical reports, especially in the field of music performance, shows that some musicians need to experience pre-performance anxiety to perform at their best level (Nideffer and Hessler, 1978). In these cases, MPA was viewed as a more positive emotion in the performance of specific individuals (Kendrick et al., 1982; Brodsky, 1996; Kim, 2005; McGinnis and Milling, 2005).

Meanwhile, MPA was reported to be a more neutral concept and was viewed as a daily healthy aspect of stress and anxiety intrinsic to the music profession. Brodsky pointed out the complex designs of previous studies and revealed the misleading definitions and ineffective remedies for managing performance-related psychological problems in musicians, indicating that the interaction between anxiety level and actual performance remained in question and needed more research (Brodsky, 1996).

We would naturally hesitate to face these contradictory views and treatments relative to MPA. If there is a type of anxiety that facilitates performance, how would it present? If this anxiety feels differently to different individuals, what would be the difference between those who perceive anxiety as excitement and those who perceive anxiety as a catastrophe?

Various representative theories explained the relationship between performance and emotions (reflecting upon mental and physical arousal). Sports psychologists increasingly agreed that unidimensional approaches to the arousal-performance or anxiety-performance relationship were ineffective and simplistic (Hanin, 2000). Thus, approaches that used a single cumulative score of anxiety to demonstrate the relationship between performance and emotions were inadequate for examining an occupation with the complex emotional and motor skill requirements of music performance. More multidimensional approaches were called for anxiety-related research.

In the 1980s, Hanin introduced the theory of the individual zone of optimal functioning (IZOF), which proposed that an athlete's performance was successful when his or her precompetitive anxiety was within or near the optimal zone (Hanin, 2000). It was a theoretical, multidimensional approach to describe, predict, and explain athletes' performance-related, biopsychosocial states that affected individual activity. Athletes were asked to imagine their biopsychosocial states, and a personal IZOF was established to predict their future performances. The IZOF proposed that an athlete's performance was successful when his or her pre-competitive anxiety was within or near the IZOF, which had been widely applied among athletes (Hanin, 2000, 2010; Harmison, 2006; Robazza et al., 2016, 2018; Ruiz et al., 2017, 2019; Cooper et al., 2021), and in physical activity at school (Robazza and Bortoli, 2005; Morano et al., 2020).

Compared to research exploring emotions in sports and the individual optimal zone, far less research had been published applying IZOF theory on MPA treatments (Yao, 2016). In music performance circumstances, as the subjective experience of anxiety varied from person to person, the optimal zone differed from person to person. By defining the optimal functioning zone for individual pianists and predicting upcoming performance results, this study verified that IZOF can still effectively describe, predict, explain, and regulate piano performance-related bio-psycho-social states as well. In particular, the location and

width of the IZOF helped determine a possible range of performance scores.

We conducted a pilot study and found the IZOF zone in two cases. The best performances by these two pianists were presented in the IZOF zone with a significantly higher IZOF score than the average out-of-zone score (Yao, 2016). In this retrospective study, IZOF was assumed to be fully applied in piano performance analysis. Moreover, the performance prediction process showed that it was vital to know each pianist's IZOF since it varied widely from person to person and may determine each pianist's personal mental and physical practice.

This study aimed to clarify pianists' personal IZOF zone, assess the contribution of MPA on their optimal performance, and examine the prediction accuracy of future performance results. This information may help pianists to prepare more and regulate their mental and physical states before future performances.

MATERIALS AND METHODS

Participants

A total of 30 participants aged between 18 and 24 years were enrolled, including 7 male and 23 advanced female pianists. Participants were all undergraduates with piano majors in a conservatory in Beijing, China. The students came from 13 different provinces in China. At the time of the survey, 6 were sophomores, 10 were juniors, and 14 were seniors, all in a 4-year bachelor's degree system. The study protocol is shown in **Figure 1**.

Ethics Statement

This study was conducted anonymously. No names or other identifying personal data were recorded. Consent forms were sent to the participants to be filled out and signed before the study began, and all included students provided signed informed consent. This study had no risks associated with the physical or psychological state of the participants.

Scoring the Piano Performances

The performances of each participant were evaluated by a group of seven professional college piano teachers. Each teacher evaluated the performance of each participant on a scale of 1–100, where 1 = worst possible performance and 100 = best possible performance. The judges were told to score the performance immediately after the performances based on the participants' playing. The score was to represent an overall impression of their performances. The highest and lowest scores were removed in the final grading, and the remaining five scores were selected and used to calculate the average score of the final performance result.

The First Phase of This Study: Locating the Zone

In the first phase of the study, participants were required to reflect upon their past four performances (2 mid-term and 2 final examinations in the past academic year) and complete the Competitive State Anxiety Inventory-2 (CSAI-2). The CSAI-2 was a self-reported inventory with 27 simple questions. It took about 5 min to complete each evaluation and was used to measure the performance anxiety state. It showed the anxiety level of the three different dimensions (subscales), namely, somatic anxiety (SA), cognitive anxiety (CA), and self-confidence (SC). The subscale scores of each dimension ranged from 9 to 36. According to data collected from the CSAI-2, the IZOF in SA, CA, and SC dimensions was identified separately for each pianist. Statistically, IZOF is shown as $M \pm 1/2$ SD. M is the mean of CSAI-2 subscales corresponding to the personal best piano performance, and SD is the standard deviation of CSAI-2 subscales. The difference (D) between the mean of in-IZOF and out-of-IZOF was calculated as performance scores and the percentage of the CSAI-2 subscale when the participant was below, in, or above the IZOF zone. Furthermore, the relative efficacy of the method for determining anxiety was compared by the percentage of outstanding or less-than-outstanding performance on the IZOF (i.e., percentage of outstanding performances inside the IZOF and less-than-outstanding outside the IZOF). We identified the outstanding performance as mean plus one SD of the 30 pianists with four performance scores. Outstanding performances in the first phase of the study were set at 92 (performance score mean: 88.98, SD: 3.47). Performance evaluations were made by seven piano teachers of judges as mentioned earlier.

The Secondary Phase of This Study: Performance Prediction

In the second phase, we evaluated the predictive accuracy of CSAI-2. The IZOF zone was identified again. Predictions can be projected for each subject based on their answers to the CSAI-2 before an upcoming jury. The IZOF theory was used for performance prediction and analysis. Subjects answered the CSAI-2 on the day before their final jury of the semester. Anxiety intensity from three subscales was compared with the upper and lower thresholds of corresponding zones to see if the subjects' performances fell within their zones. After the final jury, performance evaluations were made and collected by the same group of judges using the same method. Data were collected to examine the hypothesis that the IZOF model can help to predict the upcoming performance and be fully applied within the piano performance anxiety description, explanation, assessment, and performance prediction.

Statistical Analysis

Continuous data were presented as mean, SD, minima, and maxima. Categorical data were presented as count and percentage. In the first phase of this study, we conducted the IZOF for each pianist and calculated the performance score difference between in-IZOF and out-of-IZOF. Furthermore, we calculated the percentage of outstanding or less-than-outstanding performance on the IZOF. In the second phase of this study, a correlation between how many pianists were in or out of their IZOF and performance was analyzed. We calculated the predictive in-zone performances and the statistical

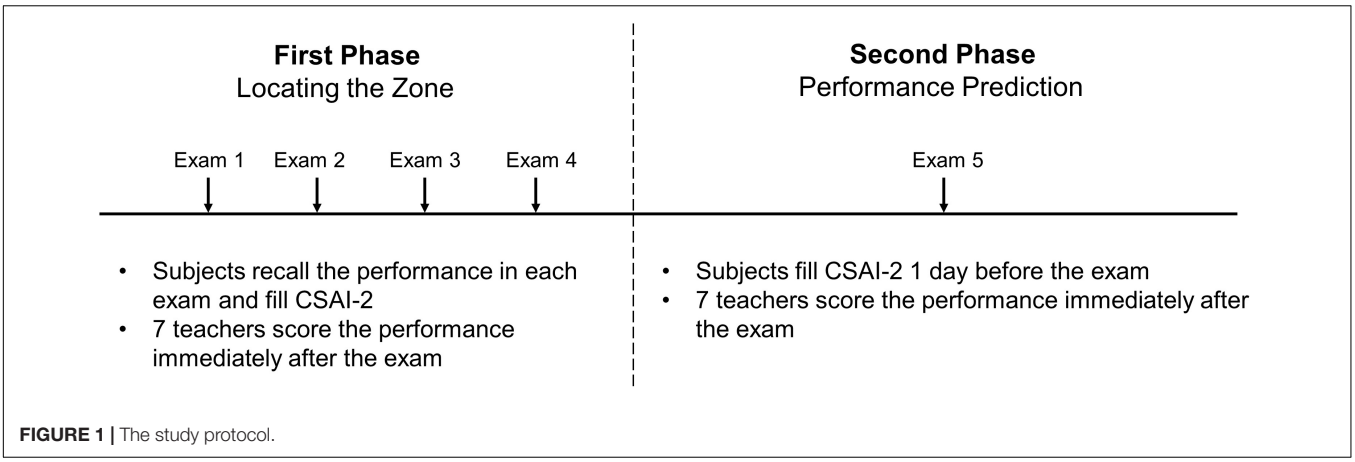

FIGURE 1 | The study protocol.

description of the actual performance score. Scatterplots were drawn to show the distance between pre-performance CSAI-2, their IZOF, and the jury's judged performance score. The distance from the closest zone border and performance score was conducted, and the distance was set to 0 if a value falls within the zone. We used the Spearman correlation coefficient to show the correlation between the distance and the performance score because these data did not show normal distribution. A two-sided p-value of <0.05 was regarded as statistically significant. Data management and statistical analyses were conducted using SAS version 9.4 software (SAS Institute, Inc.).

RESULTS

Table 1 summarizes the overall descriptive statistics for CSAI-2 subscales. The average CA score of 30 students corresponding to the best performances is 18.0 ± 4.9 (minimum-maximum: 11–34), the average SA score is 17.3 ± 4.8 (minimum-maximum: 11–26), and the average SC score is 20.9 ± 5.5 (minimum-maximum: 11–31). Students' states of CA, SA, and SC are different according to personal best performance. The individual IZOF by M ± 1/2 SD is shown in **Supplementary Table 1**.

The D (mean of in-IZOF–mean of out-of-IZOF) ranks from large to small showed that the differences in SA and SC have a similar trend (**Supplementary Table 1**). The different levels of performance scores in CA, SA, and SC range from 3.3 to 11. The average D in CA, SA, and SC are 6.2 ± 1.9, 6.2 ± 2.0, and 6.1 ± 2.1, respectively. For example, if we consider student #14, the different levels in all three subscales reach 11 and three performance scores are in the IZOF area (75%) with the best performance score of 91 ± 1 points.

TABLE 1 | Overall descriptive statistics for CSAI-2 Subscales.

	S	Cognitive anxiety		Somatic anxiety		Self-confidence	
		M	1/2 SD	M	1/2 SD	M	1/2 SD
Mean	92.8	18.0	1.3	17.3	1.2	20.9	1.6
Std	1.7	4.9	0.8	4.8	0.8	5.5	0.8
Median	92	17	1.1	16	1.1	21	1.3
Min	90	11	0.3	11	0.3	11	0.6
Max	97	34	4.3	26	4.1	31	4.1

IZOF, individual zone of optimal functioning; M, mean of CSAI-2 subscales corresponding to the best performance; SD, standard deviation of CSAI-2 subscales; S, score of performance.

TABLE 2 | Average correct classification (in percentage) of outstanding performances* inside IZOF and less-than outstanding performances outside IZOF with the CSAI-2 questionnaires.

CSAI-2 Subscales	Mean	SD	Min	Max
Cognitive anxiety	84.2	18.0	50.0	100.0
Somatic anxiety	80.8	19.3	50.0	100.0
Self-confidence	77.5	19.0	50.0	100.0

**Outstanding performances was set at 92 (performance score mean: 8 8.98, SD: 3.47).*

Table 2 shows the average correct classification (in percentage) of outstanding performances inside IZOF and less-than-outstanding performances outside IZOF with the CSAI-2 questionnaires. Outstanding performances were set at a score of 92 points. The IZOF in CA, SA, and SC results in an average of 84.2, 80.8, and 77.5%, respectively, correct predictions (all range of the three subscales: 50–100%).

Two figures were presented to display two contrasting cases of personal IZOF. **Figure 2** shows the performance distribution in the three subscales of student #14. It shows that if the student has a high CA (IZOF: 24.0–28.0) and SA (IZOF: 23.4–26.6) and a low SC (IZOF: 13.9–16.1), he or she would perform well. **Figure 3** shows that if student #29 has a low CA (IZOF: 18.0–20.0) and SA (IZOF: 15.6–16.4) and a high SC (IZOF: 20.8–25.2), he or she would have a less-than-ideal performance.

In the second phase study, the 30 participants conducted the new IZOF. **Table 3** shows the prediction in-zone performances and the statistical description of the actual performance score. A total of 14 (46.7%) students have all three subscales inside the IZOF, and the average performance score is 93.4 ± 1.5 (minimum-maximum: 91–96). A total of 60% of the participants have at least two subscales inside the IZOF

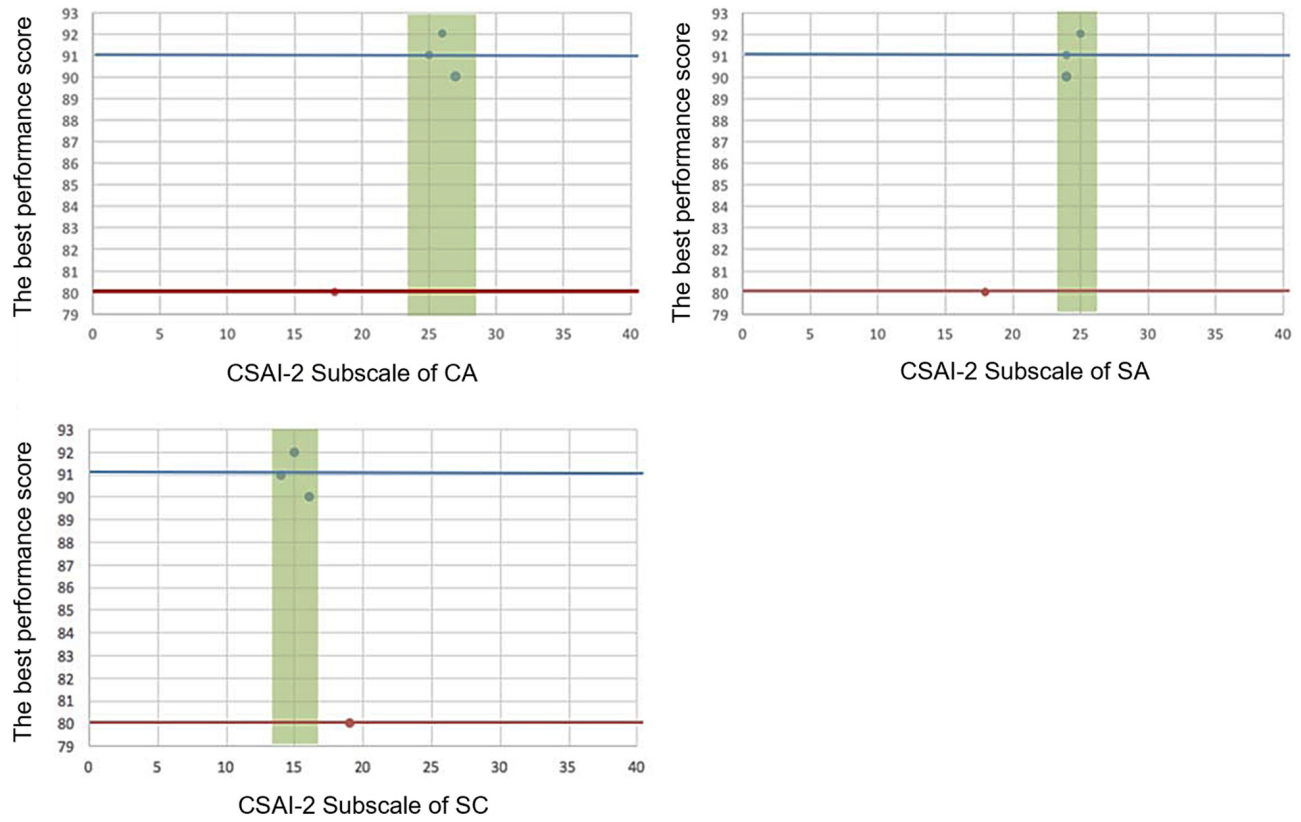

FIGURE 2 | The best performance scores and CSAI-2 subscales for participant #14. The green band represents the IZOF of participant #14. The red and blue horizontal lines represent the lowest and highest scores of the best performance scores. The blue spots indicate the performance scores.

and also receive performance scores ≥90 out of 100. In total, 10 (33.3%) students have none of the subscales inside the IZOF, and the average performance score is 86.2 ± 1.4 (minimum-maximum: 84–88). Totally, 18 (60%) and 16 (53.3%) students have CA and SA scores that fall above or in the IZOF, respectively, while 12 (40%) students have SC scores that fell below the IZOF.

Figure 4 shows the correlation between distance from closest zone border and performance score. The distance of CA, SA, and IZOF has significant strong negative correlation with the pianist's performance score (CA: $\rho = -0.79$, $p < 0.001$; SA: $\rho = -0.86$, $p < 0.001$). The distance of SC and IZOF has a moderate negative correlation with the pianist's performance score (CA: $\rho = -0.55$, $p = 0.002$).

DISCUSSION

This is the first study to apply IZOFs to musicians using CSAI-2 subscales. The results have verified the individual nature of each pianist relative to each subscale and demonstrated the zone's efficiency in describing the relationship between MPA and optimal performance. The IZOF theory can be used for pre-performance anxiety analysis and performance prediction.

The IZOF zone was found for two cases in our previous pilot study. All of their best performances were presented in the IZOFs, and their average in-zone performance score was significantly better than the average out-zone score (Yao, 2016). This study further revealed the regulation and relationship between an individual's anxiety intensity and their piano performance results. Everyone has different optimal levels of anxiety intensity. Therefore, applying the IZOF theory to music performance offers a new perspective on managing performance anxiety. With the help of the IZOF model, the study can define the "zone" in a quantified and measurable way. Moreover, with more than four sets of CSAI-2 data provided by pianists, the IZOF model may well be applied to predict pianists' upcoming performances more precisely.

Music performance anxiety has been observed from different perspectives and studied with countless methods for many years, and researchers will continue studying this area with the help of cognitive and psychological science as it is developed. However, no matter how deeply this area has been studied, individual differences in reaction to performance anxiety issues cannot be denied, especially those of advanced music majors in colleges. Music interpretation is based on technique but is an emotion-supported performance activity. It involves a great deal of personal and emotional investment, which

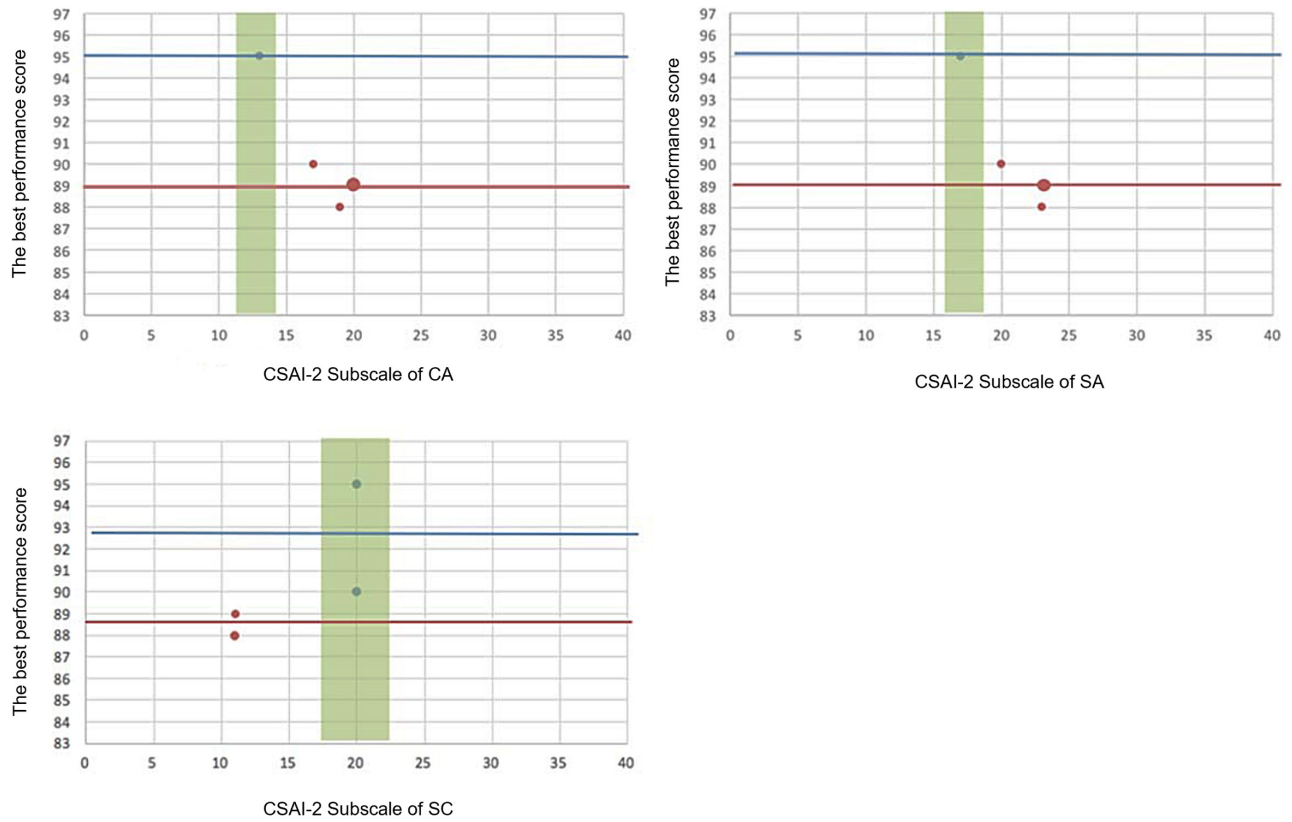

FIGURE 3 | The best performance scores and CSAI-2 subscales inside or outside the IZOF for participant #29. The green band represents the IZOF of participant #29. The red and blue horizontal lines represent the lowest and highest scores of the best performance scores. The blue spots indicate the performance scores.

TABLE 3 | Predictive in-zone performances and the statistic description of actual performance score.

Combination	SA	CA	SC	N	%	Mean	SD	Median	Min	Max
1	In	In	In	14	46.7%	93.4	1.5	93.5	91	96
2	In	In	Out	1	3.3%	95	–	95	–	–
3	In	Out	In	2	6.7%	92	1.4	92	91	93
4	Out	In	In	1	3.3%	90	–	90	–	–
5	In	Out	Out	1	3.3%	96	-	96	–	–
6	Out	In	Out	–	–	–	–	–	–	–
7	Out	Out	In	1	3.3%	88	–	88	–	–
8	Out	Out	Out	10	33.3%	86.2	1.4	86	84	88

increases uncertainty and contributes to anxiety. Individual reactions to MPA vary widely among college-level pianists. In China, students enrolled in music conservatories have already achieved an advanced level of proficiency in piano performance. However, not all of them are aware of their optimal zone for performance and attempt to master every public performance consistently with applied consciousness. As a result, even after years of training, only a few piano majors end up with a career in professional performance. With the application of the IZOF model, young pianists may become aware of certain dimensions that impact their performances in addition to technical skills and finger abilities. Therefore, knowing that the IZOF may help to enhance performance and improve personal satisfaction maybe even more important than deciding whether one should continue a performance career despite their MPA issues.

One participant who has a performance score greater than 90 has only one subscale inside the IZOF (**Table 3**, Combination 5). The participant's CA score is 19 and SC score is 28, both are very close to the lower thresholds of the optimal CA zone (19.68) and the lower thresholds of the optimal SC zone (28.11). This contradictory result may be eliminated by improving the accuracy of identifying the IZOF zone. Increasing the measured frequency of conducting IZOF or using prospective studies instead of recalling may help with improvement.

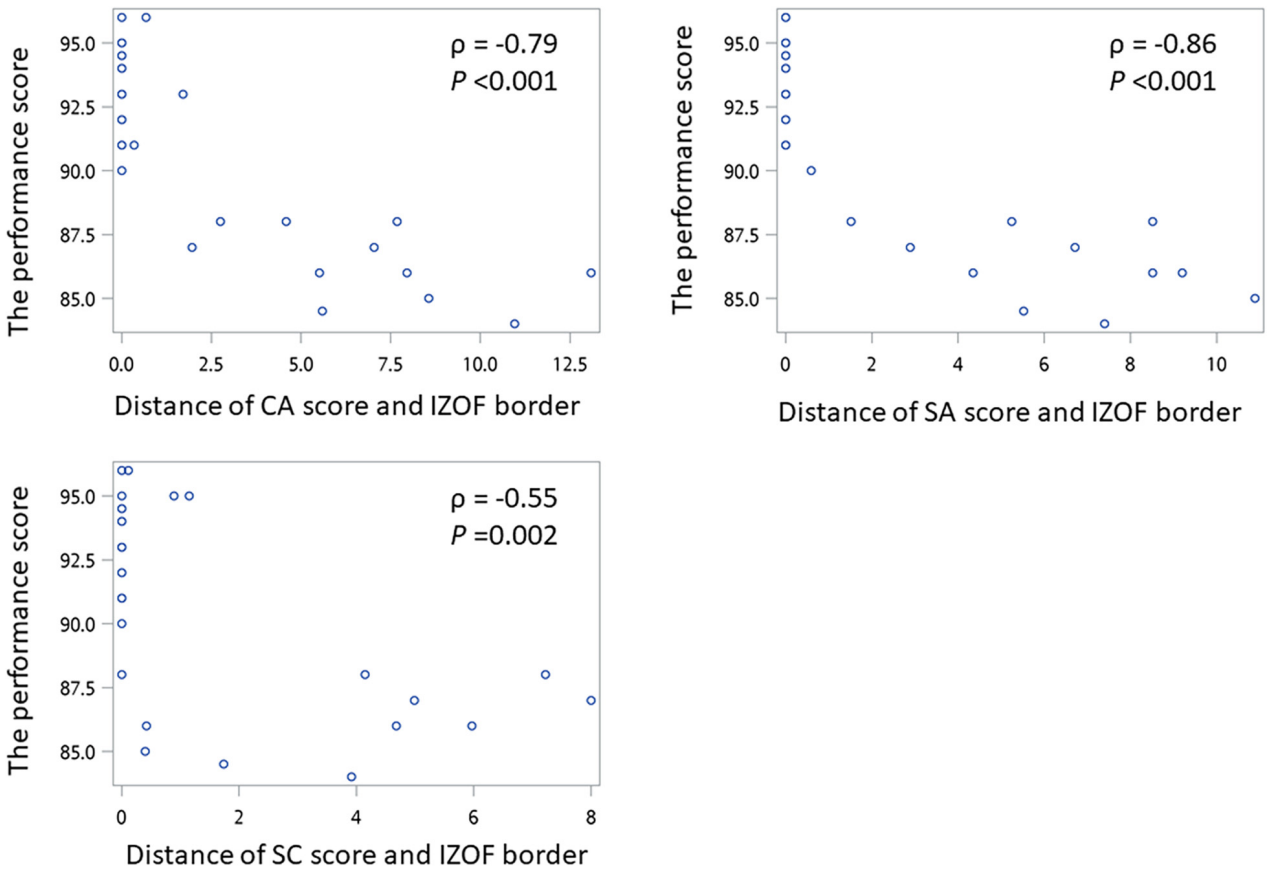

FIGURE 4 | The scatterplot of distance from closest zone border and performance score.

Limitations

This study has several limitations. First, although scholars in sports psychology have called for testing the IZOF model in more performance-related domains (Spielberger, 2013), few studies of MPA have adopted it as an applicable theory. Therefore, only limited resources can be found for comparison. Second, MPA might not be the only component affecting piano performance. The effects of other factors such as self-efficacy or social support may be underestimated and need to be considered. Third, fewer piano juries and participants may result in biased analyses and restrictions associated with future performance prediction. Piano juries are typically held four times per year, far less frequently than sports performances. Fourth, subjects were told to reflect on their most impressive performance to fulfill the retrospective recollection, which may increase the difficulty of defining the precise zone based upon fewer recollections and may result in inherent biases. Fifth, the lack of long-term data for tracking may decrease the accuracy of defining the IZOFs. Finally, since the scores did not show fluctuation for well-trained advanced performing musicians, the differences in performance scores for each person were very subtle (e.g., the lowest score was 84 and the highest was 95 on a scale of 0–100), which may affect the accuracy of prediction.

CONCLUSION

Personal IZOF zones were identified for each of the 30 pianists. Notably, 60% of the participants had at least two subscales within the IZOF and also received performance scores ≥90 out of 100. The IZOF model provides information for both piano teachers and pianists to help review their anxiety intensity and predict their performance scores to some extent.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

ZY: guarantor of integrity of the entire study, study concepts, study design, definition of intellectual content, literature research, data analysis, statistical analysis, manuscript preparation, manuscript editing, and manuscript review. YL: literature

research, clinical studies, experimental studies, and data acquisition. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.764147/full#supplementary-material

REFERENCES

Alzugaray, F. J. Z., Lopez, O. C., and Hernandez, S. O. (2016). Music performance anxiety and related psychological constructs. Students of five Spanish music conservatories. *Revista Int. de Edu. Music.* 4, 13–24. doi: 10.12967/RIEM-2016-4-p013-024

Bannai, K., Kase, T., Endo, S., and Oishi, K. (2016). Relationships among performance anxiety, agari experience, and depressive tendencies in Japanese music students. *Med. Probl. Perform. Art.* 31, 205–210. doi: 10.21091/mppa.2016.4037

Barbar, A. E., de Souza Crippa, J. A., and de Lima Osório, F. (2014). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 15, 381–386. doi: 10.1016/j.jad.2013.09.041

Bodner, E., and Bensimon, M. (2008). After the curtain falls: On the post-performance adjustment of solo singers. *Med. Probl. Perform. Art.* 23, 172–177. doi: 10.21091/mppa.2008.4035

Brodsky, W. (1996). Music performance anxiety reconceptualized: A critique of current research practices and findings. *Med. Probl. Perform. Art.* 11, 88–98.

Brugués, A. O. (2009). *Music performance anxiety: A review of the literature (Doctoral dissertation)*. Breisgau: University of Freiburg.

Brugués, A. O. (2011a). Music performance anxiety–part 1. A review of its epidemiology. *Med. Probl. Perform. Art.* 26, 102–105. doi: 10.21091/mppa.2011.2015

Brugués, A. O. (2011b). Music performance anxiety-part 2. a review of treatment options. *Med. Probl. Perform. Art.* 26, 164–171.

Burin, A. B., Barbar, A. E. M., Nirenberg, I. S., and Osório, F. L. (2019). Music performance anxiety: perceived causes, coping strategies and clinical profiles of Brazilian musicians. *Trends Psychiatry Psychother.* 41, 348–357. doi: 10.1590/2237-6089-2018-0104

Burton, D., and Naylor, S. (1997). Is anxiety really facilitative? reaction to the myth that cognitive anxiety always impairs sport performance. *J. Appl. Sport Psychol.* 9, 295–302. doi: 10.1080/10413209708406488

Casanova, O., Zarza, F. J., and Orejudo, S. (2018). Differences in performance anxiety levels among advanced conservatory students in Spain, according to type of instrument and academic year of enrolment. *Music Edu. Res.* 20, 377–389. doi: 10.1080/14613808.2018.1433145

Chamberlain, S. T., and Hale, B. D. (2007). Competitive state anxiety and self-confidence: intensity and direction as relative predictors of performance on a golf putting task. *Anx. Stress Coping* 20, 197–207. doi: 10.1080/10615800701288572

Clarke, L. K., Osborne, M. S., and Baranoff, J. A. (2020). Examining a group acceptance and commitment therapy intervention for music performance anxiety in student vocalists. *Front. Psychol.* 11:1127. doi: 10.3389/fpsyg.2020.01127

Cohen, S., and Bodner, E. (2018). Music performance skills: A two-pronged approach – facilitating optimal music performance and reducing music performance anxiety. *Psychol. Music* 2018:534.

Cooper, J. J., Johnson, M., Radcliffe, J., and Fisher, J. (2021). Optimal emotional profiles for peak performance in strength and conditioning. *J. Strength Cond. Res.* 35, 833–840. doi: 10.1519/jsc.0000000000002832

Davison, D. (2020). Sources of occupational stress among the military musicians of the Royal Air Force. *BMJ Mil. Health* 2020:1432. doi: 10.1136/bmjmilitary-2020-001432

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/s0033291719001910

Finch, K., and Moscovitch, D. A. (2016). Imagery-based interventions for music performance anxiety: an integrative review. *Med. Probl. Perform. Art.* 31, 222–231. doi: 10.21091/mppa.2016.4040

Fishbein, M., Middlestadt, S. E., Ottati, V., Straus, S., and Ellis, A. (1988). Medical problems among ICSOM musicians: overview of a national survey. Rochester, NY: Institute for Music Leadership

Guyon, A., Cannavò, R., Studer, R. K., Hildebrandt, H., Danuser, B., Vlemincx, E., et al. (2020a). Respiratory variability, sighing, anxiety, and breathing symptoms in low- and high-anxious music students before and after performing. *Front. Psychol.* 11:303. doi: 10.3389/fpsyg.2020.00303

Guyon, A., Studer, R. K., Hildebrandt, H., Horsch, A., Nater, U. M., and Gomez, P. (2020b). Music performance anxiety from the challenge and threat perspective: psychophysiological and performance outcomes. *BMC Psychol.* 8:87. doi: 10.1186/s40359-020-00448-8

Hanin, Y. L. (2000). "Individual zone of optimal functioning (IZOF) model: Emotion-performance relationships in sport," in *Emotions in Sport*, ed. Y. L. Hanin (Champaign, IL: Human Kinetics Publisher), 65–89.

Hanin, Y. L. (2010). "Coping with anxiety in sport," in *Coping in Sport: Theory, Methods, and Related constructs*, ed. A. Nicholls (Hauppauge, NY: Nova Science Publishers), 159–175.

Harmison, R. J. (2006). Peak performance in sport: Identifying ideal performance states and developing athletes' psychological skills. *Prof. Psychol. Res. Prac.* 37, 233–243. doi: 10.1037/0735-7028.37.3.233

Juncos, D. G., Heinrichs, G. A., Towle, P., Duffy, K., Grand, S. M., Morgan, M. C., et al. (2017). Acceptance and commitment therapy for the treatment of music performance anxiety: a pilot study with student vocalists. *Front. Psychol.* 8:986. doi: 10.3389/fpsyg.2017.00986

Kendrick, M. J., Craig, K. D., Lawson, D. M., and Davidson, P. O. (1982). Cognitive and behavioral therapy for musical-performance anxiety. *J. Consult. Clin. Psychol.* 50, 353–362. doi: 10.1037//0022-006x.50.3.353

Kenny, D. T. (2011). *The psychology of music performance anxiety*. New York: Oxford University Press.

Kenny, D. T., and Osborne, M. S. (2006). Music performance anxiety: New insights from young musicians. *Adv. Cogn. Psychol.* 2:495. doi: 10.2478/v10053-008-0049-5

Kenny, D. T., Arthey, S., and Abbass, A. (2016). Identifying attachment ruptures underlying severe music performance anxiety in a professional musician undertaking an assessment and trial therapy of Intensive Short-Term Dynamic Psychotherapy (ISTDP). *Springerplus* 5:1591. doi: 10.1186/s40064-016-3268-0

Khalsa, S. B., Butzer, B., Shorter, S. M., Reinhardt, K. M., and Cope, S. (2013). Yoga reduces performance anxiety in adolescent musicians. *Altern. Ther. Health. Med.* 19, 34–45.

Kim, Y. (2005). Combined treatment of improvisation and desensitization to alleviate music performance anxiety in female college pianists: a pilot study. *Med. Probl. Perform. Art.* 20, 17–24. doi: 10.21091/mppa.2005.1004

Kim, Y. (2008). The effect of improvisation-assisted desensitization, and music-assisted progressive muscle relaxation and imagery on reducing pianists' music performance anxiety. *J. Music Ther.* 45, 165–191. doi: 10.1093/jmt/45.2.165

Lee, S. H. (1988). Functional performance anxiety modifications in adult pianists by Barbara Ann McCune. *Bull. Coun. Res. Music Edu.* 2, 93–98.

Lehrer, P. M., Goldman, N. S., and Strommen, E. F. (1990). A principal components assessment of performance anxiety among musicians. *Med. Probl. Perform. Art.* 5, 12–18.

McGinnis, A. M., and Milling, L. S. (2005). Psychological treatment of musical performance anxiety: Current status and future directions. *Psychother. Theory Res. Pract. Train.* 42, 357–373. doi: 10.1037/0033-3204.42.3.357

Mor, S., Day, H. I., Flett, G. L., and Hewitt, P. L. (1995). Perfectionism, control, and components of performance anxiety in professional artists. *Cogn. Ther. Res.* 19, 207–225. doi: 10.1007/bf02229695

Morano, M., Bortoli, L., Ruiz, M. C., and Robazza, C. (2020). Psychobiosocial states as mediators of the effects of basic psychological need satisfaction on burnout symptoms in youth sport. *Int. J. Environ. Res. Public Health* 17:447. doi: 10.3390/ijerph17124447

Nideffer, R. M., and Hessler, N. D. (1978). Controlling performance anxiety. *Coll. Music Symp.* 18, 146–153.

Nusseck, M., Zander, M., and Spahn, C. (2015). Music performance anxiety in young musicians: comparison of playing classical or popular music. *Med. Probl. Perform. Art.* 30, 30–37. doi: 10.21091/mppa.2015.1005

Orejudo Hernández, S., Zarza-Alzugaray, F. J., and Casanova, O. (2018). Music performance anxiety. Substance use and career abandonment in Spanish music students. *Int. J. Music Edu.* 36, 460–472. doi: 10.1177/0255761418763903

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., and McPherson, G. E. (2021). Social support as a facilitator of musical self-efficacy. *Front. Psychol.* 12:722082. doi: 10.3389/fpsyg.2021.722082

Osborne, M. S., and Kenny, D. T. (2005). Development and validation of a music performance anxiety inventory for gifted adolescent musicians. *J. Anx. Disord.* 19, 725–751. doi: 10.1016/j.janxdis.2004.09.002

Robazza, C., and Bortoli, L. (2005). Changing students' attitudes towards risky motor tasks: an application of the IZOF model. *J. Sports Sci.* 23, 1075–1088. doi: 10.1080/02640410500128205

Robazza, C., Bertollo, M., Filho, E., Hanin, Y., and Bortoli, L. (2016). Perceived control and hedonic tone dynamics during performance in elite shooters. *Res. Q Exerc. Sport* 87, 284–294. doi: 10.1080/02701367.2016.1185081

Robazza, C., Izzicupo, P., D'Amico, M. A., Ghinassi, B., Crippa, M. C., Di Cecco, V., et al. (2018). Psychophysiological responses of junior orienteers under competitive pressure. *PLoS One* 13:e0196273. doi: 10.1371/journal.pone.0196273

Robertson, D., and Eisensmith, K. (2010). Teaching students about performance anxiety: The scratch pad pop-up model. *Music Edu. J.* 97, 31–35. doi: 10.1177/0027432109335078

Rocha, S. F., Marocolo, M., Corrêa, E. N., Morato, G. S., and da Mota, G. R. (2014). Physical activity helps to control music performance anxiety. *Med. Probl. Perform. Art.* 29, 111–112. doi: 10.21091/mppa.2014.2022

Ruiz, M. C., Haapanen, S., Tolvanen, A., Robazza, C., and Duda, J. L. (2017). Predicting athletes' functional and dysfunctional emotions: The role of the motivational climate and motivation regulations. *J. Sports Sci.* 35, 1598–1606. doi: 10.1080/02640414.2016.1225975

Ruiz, M. C., Robazza, C., Tolvanen, A., Haapanen, S., and Duda, J. L. (2019). Coach-created motivational climate and athletes' adaptation to psychological stress: temporal motivation-emotion interplay. *Front. Psychol.* 10:617. doi: 10.3389/fpsyg.2019.00617

Sabino, A. D. V., Chagas, M. H. N., and Osório, F. L. (2020). Acute effects of oxytocin in music performance anxiety: a crossover, randomized, placebo-controlled trial. *Psychopharmacology* 237, 1757–1767. doi: 10.1007/s00213-020-05493-0

Shaw, T. A., Juncos, D. G., and Winter, D. (2020). Piloting a new model for treating music performance anxiety: training a singing teacher to use acceptance and commitment coaching with a student. *Front. Psychol.* 11:882. doi: 10.3389/fpsyg.2020.00882

Sousa, C. M., Machado, J. P., Greten, H. J., and Coimbra, D. (2016). Occupational diseases of professional orchestra musicians from northern portugal: a descriptive study. *Med. Probl. Perform. Art.* 31, 8–12. doi: 10.21091/mppa.2016.1002

Spahn, C. (2015). Treatment and prevention of music performance anxiety. *Prog. Brain Res.* 217, 129–140. doi: 10.1016/bs.pbr.2014.11.024

Spielberger, C. D. E. (2013). *Anxiety and Behavior*. New York, NY: Academic Press.

Steptoe, A. (2001). "Negative emotions in music making: The problem of performance anxiety," in *Music and Emotion: Theory and Research. Series in Affective Science*, eds P. N. Juslin and J. A. Sloboda (New York, NY: Oxford University Press), 291–307.

Studer, R. K., Danuser, B., Wild, P., Hildebrandt, H., and Gomez, P. (2014). Psychophysiological activation during preparation, performance, and recovery in high- and low-anxious music students. *Appl. Psychophysiol. Biofeedback* 39, 45–57. doi: 10.1007/s10484-014-9240-2

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Su, Y. H., Luh, J. J., Chen, H. I., Lin, C. C., Liao, M. J., and Chen, H. S. (2010). Effects of using relaxation breathing training to reduce music performance anxiety in 3rd to 6th graders. *Med. Probl. Perform. Art.* 25, 82–86. doi: 10.21091/mppa.2010.2016

Tang, Y., and Ryan, L. (2020). Music performance anxiety: can expressive writing intervention help? *Front. Psychol.* 11:1334. doi: 10.3389/fpsyg.2020.01334

Topoğlu, O. (2014). Musical performance anxiety: relations between personal features and state anxiety levels of pre-service music teachers. *Int. Online J. Edu. Sci.* 6, 337–348.

van Fenema, E. M., Gal, P., van de Griend, M. V., Jacobs, G. E., and Cohen, A. F. (2017). A pilot study evaluating the physiological parameters of performance-induced stress in undergraduate music students. *Digit. Biomark.* 1, 118–125. doi: 10.1159/000485469

Wolfe, M. L. (1989). Correlates of adaptive and maladaptive musical performance anxiety. *Med. Probl. Perform. Art.* 4, 49–56.

Yao, Z. (2016). Anxiety and optimal piano performance: a pilot study on the application of the individual zone of optimal functioning (IZOF) Model. *Int. J. Psychol. Stud.* 8:60. doi: 10.5539/ijps.v8n4p60

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Zarza-Alzugaray, F. J., Casanova, O., McPherson, G. E., and Orejudo, S. (2020). Music self-efficacy for performance: an explanatory model based on social support. *Front. Psychol.* 11:1249. doi: 10.3389/fpsyg.2020.01249

Zarza-Alzugaray, F. J., Orejudo, S., Casanova, O., and Aparicio-Moreno, L. (2018). Music Performance Anxiety in adolescence and early adulthood: Its relation with the age of onset in musical training. *Psychol. Music* 46, 18–32. doi: 10.1177/0305735617691592

Zhukov, K. (2019). Current approaches for management of music performance anxiety: An introductory overview. *Med. Probl. Perform. Art.* 34, 53–60. doi: 10.21091/mppa.2019.1008

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Development of Flow State Self-Regulation Skills and Coping With Musical Performance Anxiety: Design and Evaluation of an Electronically Implemented Psychological Program

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Positive Psychology has turned its attention to the study of emotions in a scientific and rigorous way. Particularly, to how emotions influence people's health, performance, or their overall life satisfaction. Within this trend, Flow theory has established a theoretical framework that helps to promote the Flow experience. Flow state, or optimal experience, is a mental state of high concentration and enjoyment that, due to its characteristics, has been considered desirable for the development of the performing activity of performing musicians. Musicians are a population prone to health problems, both psychological and physical, owing to different stressors of their training and professional activity. One of the most common problems is Musical Performance Anxiety. In this investigation, an electronic intervention program was carried out for the development of psychological self-regulation skills whose main objective was to trigger the Flow response in performing musicians and the coping mechanism for Musical Performance Anxiety. A quasi-experimental design was used with a control group in which pre- and post-measures of Flow State, Musical Performance Anxiety and, also, Social Skills were taken. Sixty-two performing musicians from different music colleges in Spain participated in the program. Results indicated that the intervention significantly improved Flow State ($t = -2.41$, $p = 0.02$, $d = 0.36$), and Sense of Control ($t = -2.48$, $p = 0.02$, $d = 0.47$), and decreased Music Performance Anxiety ($t = 2.64$, $p = 0.01$, $d = 0.24$), and self-consciousness ($t = -3.66$, $p = 0.00$, $d = 0.70$) of the participants in the EG but not CG. The changes in the EG after the program showed the inverse relationship between Flow and Anxiety. Two important theoretical factors of both variables (especially in situations of performance and public exposure), such as worry and the feeling of lack of control, could be involved. The results are under discussion and future lines of research are proposed.

Keywords: Flow state, performing musicians, Musical Performance Anxiety, social skills, electronic intervention program, Flow experience

INTRODUCTION

From the Positive Psychology approach, the study of emotions has been addressed to try to understand how they influence people's health, performance, or their overall life satisfaction (Seligman, 2008).

In a review of 12 school-based interventions to foster student well-being and academic performance, following a Positive Psychology approach, it was found that implemented programs were consistently related to student well-being, social relationships, and academic performance (Waters, 2011). In the specific field of music, an attempt has been made to understand how professional musicians experience well-being in the light of Positive Psychology (Ascenso et al., 2017).

Framed in Positive Psychology, Flow theory (Csikszentmihalyi, 1975, 1990; Csikszentmihalyi and Csikszentmihalyi, 1988; Csíkszentmihályi, 1997) has established a framework that, specifically in the field of sport, has contributed to developing the psychological skills of athletes to optimize their enjoyment and performance (Jackson and Csikszentmihalyi, 1999; Norsworthy et al., 2017; Jackman et al., 2019).

In the same line of thought, for a few years now, the need for musicians to develop self-regulation skills has been considered, which would complete an education focused on eminently technical-performance aspects (Brodsky, 1996; Williamon, 2004; Clark and Williamon, 2011; Wrigley and Emmerson, 2013; Cohen and Bodner, 2019a; Moral-Bofill et al., 2022).

It has been noted how musical performance poses multiple simultaneous demands at the cognitive (Kenny and Osborne, 2006), affective (Kenny, 2005), conative, and kinesthetic (Altenmüller et al., 2000), and motor system (Kenny and Ackermann, 2015) levels. In fact, performing musicians are exposed to a relatively high risk of physical and psychological stress that can lead to disorders and health problems. In order to cope better with all these demands (physical, psychological, and social), the need to implement appropriate interventions has been suggested to help make their musical career rewarding and steady over time (Kenny and Ackermann, 2016).

Recent studies have suggested that the psychosocial work environment of musicians may be considered more demanding than that of other occupations (Holst et al., 2012; Burak and Atabek, 2019; Détári et al., 2020; Musgrave and Gross, 2020). For example, Vaag et al. (2016) reported that, compared to the general population, professional musicians had more symptoms of anxiety and depression. It also appears that music students show a greater number of these symptoms compared to the general student population (Spahn et al., 2004; Vaag et al., 2021), in addition to lower levels of self-efficacy and self-regulation (Ginsborg et al., 2009), and psychosocial well-being (Panebianco-Warrens et al., 2015). Anxiety and depression are not only highly prevalent among music students, but their symptom burden is even higher than that seen among professional musicians (Kegelaers et al., 2021).

One of the most common and specific problems of performing musicians is Musical Performance Anxiety (MPA). MPA is the experience of strong and persistent anxious apprehension related to a musical performance, which manifests as a combination of affective, cognitive, somatic, and behavioral symptoms. It is triggered in different performance contexts, but it is more intense when (a) the performer is overly concerned about their image, (b) there is fear of evaluation and judgment from others, and (c) there is a fear of making mistakes. Although it can be specific, focused on musical performance, it can also occur alongside other anxiety disorders, for example, social anxiety disorder (Kenny, 2011). Numerous studies show how MPA can affect musicians of any age and at any stage of their education or career (Fishbein et al., 1988; Ryan, 2005; Kenny D. et al., 2014). In fact, musicians under 30 have a higher risk of experiencing it (Kenny D. et al., 2014). This could be related to the lower level of performing experience of performing musicians in college (Biasutti and Concina, 2014). Students, therefore, may suffer from MPA in addition to experiencing periods of burnout (Bernhard, 2010) and considering continuing as performing musicians (Fehm and Schmidt, 2006; Osborne, 2016). It is also necessary to mention that gender is an important factor related to MPA. Numerous studies have found that there is a higher prevalence and intensity of MPA in women than in men (cf. Burin and Osorio, 2017).

On the other hand, it has been suggested that anxiety has a negative relationship with a Flow state (Csikszentmihalyi, 1975). This has led to the suggestion that interventions to promote a Flow state could contribute to the reduction of MPA and facilitate musical performance (Lamont, 2012; Wrigley and Emmerson, 2013; Iusca, 2015; Cohen and Bodner, 2019a). In fact, studies have been published that have found negative correlations between MPA and Flow in musicians (Kirchner et al., 2008; Fullagar et al., 2013; Stocking, 2013; Cohen and Bodner, 2019a; Moral-Bofill et al., 2022).

Flow State (FS) is a subjective state of mind in which a person is involved in what they are doing, highly focused, carefree, and with a positive emotion of gratification (Csikszentmihalyi, 1990). People describe FS in the same way, regardless of culture, social class, gender, or different fields of activity, such as work and leisure. Research has identified the different components involved in Flow. These components are usually conceptualized as those elements that phenomenologically configure FS and the factors that are considered to be the conditions for that FS to occur (Nakamura and Csikszentmihalyi, 2009). With regard to these previous conditions, the following have been noted: (1) There is a balance between the skills and the challenge to be faced (balance). (2) Having clear goals (goals). (3) Receiving clear feedback on how the activity is progressing (feedback). Whereas, the six components that characterize FS would be: (1) Concentration on the task (concentration): describes the intense and focused concentration on the present moment. (2) Merging of awareness and action (merging): reflects a feeling of acting effortlessly, with a deep involvement that removes awareness of the concerns and pressures of daily life. (3) Loss of self-consciousness (consciousness): manifests the decrease and/or disappearance of self-consciousness as a social actor. (4) Sense of control (control): feeling like oneself can control one's actions and can cope with the situation. (5) Transformation of time (time): having the feeling that time has passed in a different way (e.g., faster, or slower than normal). (6) Autotelic experience (autotelic): the activity is experienced as intrinsically rewarding,

a matter that establishes the highly positive emotional value of this experience.

It has been noted that it is important to properly operationalize FS as an optimal state of consciousness that is relatively rare in daily life, intrinsically rewarding and differentiated from the conditions that cause it (balance, goals, and feedback) (Abuhamdeh, 2020).

Flow state has been investigated in different fields. In the field of Sports Psychology, it is a widely researched construct and the works of Susan Jackson have been considered as a reference (Jackson and Eklund, 2002, 2004). But it has also been investigated in other areas, such as work (Csikszentmihalyi and Lefevre, 1989; Bryce and Haworth, 2002; Eisenberger et al., 2005; Peifer and Wolters, 2021), education (Carli et al., 1988; Bakker, 2005; Rathunde and Csikszentmihalyi, 2005), creativity (Csikszentmihalyi, 1996, 2006; Csikszentmihalyi and Rich, 1998), leisure (Lefevre, 1988; Schallberger and Pfister, 2001), the arts (cf. Harmat et al., 2021), human–computer interaction (Triberti et al., 2021), or recently in high capacities (Moral-Bofill et al., 2020a). The field of music psychology has not been a stranger to this interest (cf. Chirico et al., 2015; Tan and Sin, 2021), more and more studies are being found in the field of music education and/or related to musical performance (Custodero, 2002, 2005; Fritz and Avsec, 2007; Sinnamon et al., 2012; Fullagar et al., 2013; Marin and Bhattacharya, 2013; Wrigley and Emmerson, 2013; Iusca, 2015; Cohen and Bodner, 2019a,b; Moral-Bofill et al., 2020b). In educational and training contexts, it is considered a source of motivation that can promote learning and the development of skills over time (Nakamura and Csikszentmihalyi, 2009). In the field of music, it has been considered a rewarding and motivating experience that promotes the desire to continue doing the activity that is being carried out (Custodero, 2002, 2005). It has been linked to creativity, enhancing creative composition activities (Byrne et al., 2003; MacDonald et al., 2006). In the case of performing musicians, it has been suggested that it may contribute to greater enjoyment of the performing activity and a reduction in MPA (Kirchner et al., 2008; Sinnamon et al., 2012; Fullagar et al., 2013; Wrigley and Emmerson, 2013; Iusca, 2015; Cohen and Bodner, 2019a,b; Moral-Bofill et al., 2020b); as well as the musicians continuing to be involved in music (Woody and McPherson, 2010).

Finding FS relationships with other variables appears as a research area that can help to understand ways to promote FS. According to Flow theory, there is the concept of "autotelic" personality which suggests that certain personal characteristics may represent a greater disposition to undergo the Flow experience (Csikszentmihalyi, 1990). There are studies that have shown that Flow has a negative relationship with neuroticism and a positive relationship with responsibility, but not with intelligence (Ullén et al., 2012). It has also been suggested that people with a high internal locus of control scores may enjoy the activity more when faced with challenges and reach FSs more easily (Keller and Blomann, 2008; Mosing et al., 2012). But also, the need for achievement (Eisenberger et al., 2005), mental tenacity (Crust and Swann, 2013), self-control (Kuhnle et al., 2012), the quest for novelty, and persistence (Teng, 2011), have shown positive relationships with Flow.

A systematic review has also shown that there is a small to moderate relationship between FS and performance. The results show that such a relationship is consistent in both games and sports activities (Harris et al., 2021).

Other factors related to FS are emotions. FS is related to a positive emotional state and is one of the factors that has been identified as a determinant of subjective well-being (Csikszentmihalyi, 1990). In music students, positive relationships have been found between the positive emotional aspects of subjective well-being and the predisposition for Flow (Fritz and Avsec, 2007). Both the hours dedicated to practice and emotional intelligence, evaluated with self-report measures, have been shown to be predictors of Flow in pianists (Marin and Bhattacharya, 2013).

In fact, Flow theory provides a framework to promote a more positive and satisfying relationship with performing an activity and preventing MPA. Most forms of performance anxiety are difficult to treat, and a person's anxiety level after undergoing treatment is rarely reduced to the anxiety levels experienced by non-anxious people (Kenny, 2005). For this reason, the best ways to address the problem of MPA would be, on the one hand, to prevent its occurrence (Spahn, 2015; Kenny and Ackermann, 2016) and, on the other, implementing positive coping strategies in an educational context, from very early on (Spahn, 2015).

Alongside the research that has focused on identifying the problems that occur in the field of musicians' health, there has been an increased focus on the prevention of these problems and the promotion of artists' health during their musical and artistic education (Araújo et al., 2017; Perkins et al., 2017; Matei et al., 2018; Aalberg et al., 2019). Prior to this focus on health promotion and prevention of disorders or health problems, there is a significant volume of research that has focused on trying to find solutions for MPA. Cognitive behavioral therapy (CBT) is the one with the greatest scientific support in terms of its efficacy in treating it (Kenny, 2011). In the case of severe MPA (with panic and depression), short-term intensive dynamic psychotherapy has shown more promising results (Kenny D. T. et al., 2014; Kenny, 2016; Kenny et al., 2016). Mention should also be made of treatment with beta-blockers, which are used, according to studies, by up to 31% of professional orchestral musicians to reduce symptoms of physiological arousal associated with MPA (Kenny D. et al., 2014).

Other interventions for the treatment of MPA have also been studied, such as biofeedback (Egner and Gruzelier, 2003; Thurber et al., 2010), yoga (Khalsa et al., 2013), the Alexander technique (cf. Klein et al., 2014), or guided imagery with progressive muscle relaxation (Kim, 2008); however, the evidence for this type of intervention is lower and there are significant methodological limitations (Burin and Osorio, 2017; Juncos and de Paiva e Pona, 2018).

Recently, research has been presented that has studied the effects of psychological interventions for the treatment of MPA such as acceptance and commitment therapy (Juncos and de Paiva e Pona, 2018; Clarke et al., 2020; Shaw et al., 2020) or expressive writing (Tang and Ryan, 2020). These studies show satisfactory results and may be the beginning of a new approach

to dealing with MPA, but, for now, they are also case studies or have very small samples, so further research is necessary.

Within an approach that is more focused on the prevention of MPA problems and the promotion of adaptive coping habits for this problem, and due to the many common characteristics of sports and musical performances, research has been presented that studies the effects of specific intervention programs. These interventions place an emphasis on psychological techniques such as mental rehearsal, goal setting, focusing on strengths, with the ultimate goal of reaching FS or a full immersion experience in a performance (Williams, 2010). Some intervention studies that integrate sport and performance psychology methods have shown improvements in reducing MPA (Clark and Williamon, 2011; Hoffman and Hanrahan, 2012; Osborne et al., 2014; Braden et al., 2015; Cohen and Bodner, 2019b) as well as in musical performance (Hoffman and Hanrahan, 2012; Cohen and Bodner, 2019b). However, these studies did not record Flow experience measures, with the exception of Cohen and Bodner (2019b) who took Flow measures with the "Dispositional Flow Scale-2" short scale (Martin and Jackson, 2008). The results of the intervention showed a statistically significant reduction in MPA. However, no differences were observed in the measures of Flow. However, in a recent study (Moral-Bofill et al., 2022) involving 139 performing musicians (college students and professionals) the results of the regression analysis showed that some of the same variables predicted both FS and MPA, while other variables predicted either FS or MPA (e.g., the variable Social Skills predicted both FS and MPA; Gender MPA; or Clear Study and Interpretive Objectives FS). In addition, they suggested that the musicians' motivation and determination to develop their musical career could partially influence the FS experience, although it doesn't necessarily affect the MPA levels (Moral-Bofill et al., 2022). Therefore, it is possible that interventions aimed at increasing FS may need to develop specific strategies aimed at that goal.

One challenge in evaluating the effects of intervention programs for the development of psychological skills for performance is the difficulty of implementing these programs over a long period of time and that, in addition, they are linked to the curricular activities of schools. The results of the analysis of a vast amount of research in the field of socio-emotional learning (SEL) in compulsory education, indicate that for effective learning of self-regulation skills, regular and consistent practice of these skills is necessary and, furthermore, that involvement of different educational strata is needed for optimal implementation (Durlak et al., 2011; Taylor et al., 2017). According to Bisquerra (2006), the importance of emotional education, in addition to the field of "formal education," has spread to any life stage and also to different contexts. On the other hand, advances in neuroscience justify the need to consider emotions in education (Zull, 2006; Carew and Magsamen, 2010; Dolcos et al., 2011; Jung et al., 2014; Seli et al., 2016; Vogel and Schwabe, 2016; Tyng et al., 2017), not least because they are involved in self-regulation and attention control, and, in general, the development of cognitive skills. Also, from the multifaceted approach to intelligence, the importance of each and every intelligence needing adequate stimulation for their learning is noted. Personal intelligence (Gardner, 1983) too, since understanding and regulating emotional aspects, like other information processing capabilities, are learned. The implications of this argument are very relevant since it justifies the implementation of emotional education or SEL programs. But also, for these to be effective, they must be regular and consistent. This means that the curriculum has to consider dedicating regular hours to explicit learning of emotional skills development (Moral-Bofill et al., 2015). There are also results from mindfulness studies that show that regular practice is essential for promoting positive emotions, improving concentration and states of physiological relaxation (Davidson et al., 2003). Mindfulness develops and deepens over time, but requires a continuous commitment to its practice (Kabat-Zinn, 2003; Davidson, 2010).

A recent article has reviewed the benefits of integrating various approaches to MPA prevention or treatment and how it can contribute to the musician's psychological training and performance preparation process. In this article, the contributions of emotion psychology and emotional regulation are shown as key elements for an appropriate approach to the MPA phenomenon, without forgetting the role of clinical psychology, performance psychology, and positive psychology (Kaleńska-Rodzaj, 2021).

Another recent study has found a strong relationship between MPA, social anxiety, and perfectionism, suggesting that some musicians with MPA also show symptoms of a co-morbid social phobia that is not specifically related to performance (Dobos et al., 2019). Evidence of this co-morbidity between social phobia (and other anxiety disorders) and MPA has also been shown in previous studies (Kenny, 2010).

Supporting this relationship with social anxiety, a recent study has found that social avoidance is among the set of MPA predictors (Lupiáñez et al., 2021). In fact, according to some studies, social skills are part of the necessary skill set for the performance of musicians (Kemp, 1996; Gaunt and Hallam, 2009). A recent study has found that both FS and MPA show statistically significant relationships (positive and negative, respectively) with social skills (Moral-Bofill et al., 2022). It has also been found that social relationships are a central aspect for musicians, and being successful in them presents a challenge both in the work and personal context, so it is suggested that social skills training is important in the context of professional music (Ascenso et al., 2017).

Previous studies show the importance of interpersonal relationships and social skills for performing musicians, as well as associations between MPA and social anxiety. However, interventions carried out to address the problem of MPA tend to focus on aspects of the individual (such as mental training, exposure, internal dialogue, activation control, etc.) and are generally focused on performance. A broader perspective would be for interventions to implement strategies for musicians to develop emotional and social awareness and regulation skills beyond specific performance preparation.

On another note, Internet use has expanded the way mental health interventions are implemented (Botella et al., 2009). Findings from different studies suggest an emerging evidence base supporting web-based mental health to support or treat a wide variety of mental disorders (Andersson and Titov, 2014; Lal and Adair, 2014); such as post-traumatic stress disorder (Kuester et al., 2016; Kuhn et al., 2017; Simblett et al., 2017),

dissociative disorders (Brand et al., 2019; Fung et al., 2020), schizophrenia (Rotondi et al., 2010), anxiety (Reger and Gahm, 2009), or depressive symptoms (Karyotaki et al., 2021). Internet-based interventions have been found to be effective in reducing (mainly in adults) the symptoms of the most common mental disorders such as depression, anxiety, substance abuse, and eating disorders. However, more efforts are needed to implement and evaluate these types of programs in other contexts (Taylor et al., 2021). For example, evidence in the youth population is limited and further research and program development is needed (Reyes-Portillo et al., 2014). In any case, the results show that they are a promising resource for the psychological treatment of depression (Andersson and Cuijpers, 2009) and anxiety (Penate and Fumero, 2016). In addition, they improve even more when combined with some type of contact with the therapist. Notwithstanding, the disadvantage is that a higher dropout rate is noted (Penate and Fumero, 2016). Furthermore, it has been shown that they can be effective in managing stress in adults (Heber et al., 2017), in university students (Frazier et al., 2015) and in employees (Heber et al., 2016). In higher education students, a study differentiated between mental health prevention treatments aimed at students without a specific diagnosis compared to those aimed at students with a mild or moderate disorder. The results showed that the skills training interventions obtained medium and statistically significant effect sizes in both types of intervention. In addition, those interventions aimed at students with a specific diagnosis obtained better results when the participants had access to some type of support, face-to-face or online (Conley et al., 2016). Other results with university students showed that interventions designed from modules for the development of skills (promotion) can have a significant impact on the mental health of adolescents; however, more studies are needed to support this. On the other hand, the results of interventions aimed at prevention showed a statistically significant positive effect of CBT on symptoms of anxiety and depression in adolescents and young adults. In addition, the results suggested that face-to-face and/or online support for participants was an important feature for program completion and program outcomes (Clarke et al., 2015). Another systematic review showed that Internet interventions for mental health had small to moderate statistically significant effects on a range of conditions (depression, anxiety, stress, sleep problems, and eating disorders) but not on well-being. However, it is suggested that more research is needed to determine which interventions are most effective for different groups of students and to explore ways to increase treatment effectiveness (Harrer et al., 2019). Specifically, in the context of musicians, Ingle (2014) evaluated the effectiveness of an Internet-based health promotion program targeting Australian elite music students. A combined in-person and online learning program has also been carried out, with the aim of increasing self-efficacy levels in adolescent students through training in psychological skills for performance (Gill, 2019).

Furthermore, for the first time, the global impact of the COVID-19 pandemic has increased the demand for mental health services, and internet-based interventions may be particularly suitable for this purpose (Brog et al., 2022). For the same reason, as a consequence of COVID-19, schools have implemented many Internet-based educational platforms (Okmawati, 2020). Google Classroom is one of the technologies used (Sharda and Bajpai, 2021), also in university education (Gour, 2018). Probably due to its easy access and its free form, Google classroom is the most used worldwide (Ríos-Lozada et al., 2022). The results on its use suggest that it is an efficient and functional tool (Gour, 2018; Okmawati, 2020; Sharda and Bajpai, 2021), and it is perceived as a comfortable and easy-to-use technology (Santos, 2021).

The main objective of this research was to evaluate the effects of a program designed to promote FS and deal with MPA through the development of self-regulation skills. The program was aimed at a group of students and professors from a music conservatoire who are active performing musicians. Two dependent variables were considered: (a) FS and (b) MPA. As a secondary objective, the program's effects on the variable Social Skills (SS) were studied.

The following hypotheses were made:

(1) The existence of significant differences in FS between the control group and the experimental group (EG) will be determined.
(2) The existence of significant differences in MPA between the control group and the EG will be determined.
(3) The existence of significant differences in SS between the control group and the EG will be determined.
(4) Significant differences in any of the variables considered in the control group will not be determined.

MATERIALS AND METHODS

Research Design

This research was carried out using a quasi-experimental design that use both control groups and pretests. Specifically, we used the untreated control group design with dependents pretest and posttest sample. This design is frequently called the nonequivalent comparison group design, that is, may be, the most common of all quasi-experiments (Shadish et al., 2002).

Participants

Senior music students or active performing teachers who had an internet-connected device and a Gmail email account were able to apply to participate in this program. They also had to consent to the research and agree to a declaration of commitment and sincerity to the program (see **Supplementary Material 1**). In addition to these requirements, the criteria for inclusion in the study were as follows: (a) being of legal age, (b) participation in at least 80% of the program's activities, and (c) adequate completion of the measuring instruments applied over the duration of the program (pre-post). In the case of the control group, the last of the listed criteria and being of legal age were applied. Of the initial 142 participants who were enrolled, 80 did not meet the criteria for inclusion in the study, so ultimately 62 performing musicians participated in the research. Of these, 50 were students at the music conservatoire and 12 were vocational or higher education teachers. The age bracket ranged from 18 to 61 ($m = 27.58$

and *de* = 10.56). 32% (*n* = 20) were men (mean age = 30.25 and *DE* = 10.94) and 68% (*n* = 42) were women (mean age = 26.31 and *DE* = 10.26). The participants were divided into two groups based on the information collected in the form they completed and where the requirements for participation in the program had been explained. The participants who met all the requirements and agreed with the commitment of participation were part of the EG. Of the rest of the participants, those who met the basic requirements of being of legal age and performing musicians (senior students or active performing teachers), and agreed to the commitment to respond to the forms 3 months later, were part of the control group (CG). The rest of the participants were excluded from the research. EG consisted of *N* = 28 (9 men, mean age = 28.33 and *DE* = 11.57 and 19 women, mean age = 27.63 and *DE* = 12.57). CG was made up of *N* = 34 (11 men, mean age = 31.82 and SD = 10.69 and 23 women, mean age = 25.22 and *SD* = 8.01). **Table 1** shows the percentages of participants based on the categorical variables collected for each group and for the total number of participants.

Instruments

- Flow State Scale for Musical Performers (EFIM in its Spanish acronym) (Moral-Bofill et al., 2020b). This is a 24-item questionnaire that measures FS. It consists of six scales, each composed of conceptually different items. The scales covered by this instrument are as follows: action-awareness merging; concentration on the task; sense of control; loss of self-consciousness; transformation of time; and autotelic experience. To assess the degree of agreement with the formulation of each item, a Likert scale from 0 to 10 points is used, where 0 is strongly disagree and 10 is strongly agree. The scores for each of the six scales can be obtained separately, as well as overall FS. To respond to the EFIM scale, you must first specify the situation that is referenced to answer. The most appropriate time to answer the questions presented by this tool is at the end of the activity proposed as a criterion (Moral-Bofill et al., 2020b). The present research called for the situation to be a concert or public audition situation. Rates of reliability with Cronbach's Alpha are greater than 0.80 on all scales and 0.92 for the FS global scale.
- KMPAI-E (Arnáiz, 2015), is the Spanish adaptation of the Kenny Music Performance Anxiety Inventory, K-MPAI (Kenny, 2009, 2011). The KMPAI-E is constructed of 40 items encompassing the cognitive, physiological, and behavioral dimensions of performance anxiety related to musical performance (Kenny, 2009, 2011). An overall MPA score is obtained. The scale shows a reliability scale with Cronbach's Alpha of 0.91.
- Social Skill Scale, SSS (Gismero, 2010). Two subscales of the SSS have been used: Self-expression in social situations, made up of eight items; and Initiating positive interactions with the opposite sex, made up of five items. In total, 13 items are answered with a Likert scale of 1–4, where 1 is equal to "I do not relate at all; most of the time that does not happen to me or I would not do it" and 4 equals "I strongly agree and I would feel or act like this in most cases." The subscale Self-expression in social situations reflects the ability to express oneself spontaneously and without anxiety, in different types of social situations. Obtaining a high score indicates ease of interactions, expressing one's own opinions and feelings, asking questions, etc. The subscale Initiating positive interactions with the opposite sex tries to measure the ability to initiate positive interactions with people of the opposite sex who may be attractive, be it a conversation, asking for a date, spontaneously giving a compliment, etc. A high score indicates ease of such behaviors. Reliability with the global scale Cronbach's Alpha is 0.88.
- Form for obtaining sociodemographic data. A Google form was used that can be programmed so that none of the questions are left unanswered. As **Table 1** shows, the form collected information on gender; current work; musical style; and the musical instrument.

TABLE 1 | Percentage of total participants and by groups according to the categorial variables considered.

Variable	Categories	% Total (*N* = 62)	% GE (*n* = 28)	% GC (*n* = 32)
Gender				
	Men (*n* = 20)	32.3%	32.1%	32.4%
	Women (*n* = 42)	67.7%	67.9%	67.6%
Work				
	Student (*n* = 50)	80.6%	67.9%	91.17%
	Professor (*n* = 12)	19.4%	32.1%	8.8%
Musical style				
	Classical (*n* = 57)	91.9%	96.4%	88.2%
	Other (*n* = 5)	8.1%	3.6%	11.76%
Musical instrument				
	Woodwind (*n* = 13)	21%	7.1%	32.4%
	Piano (*n* = 11)	17.7%	25%	11.8%
	Singer (*n* = 12)	19.4%	14.3%	23.5%
	Strings (*n* = 17)	27.4 %	35.7 %	20.6 %
	Other (*n* = 9)	14.4%	17.9%	11.8%

Procedure

The project was endorsed by the Department of Behavioral Sciences Methodology in the Faculty of Psychology at the National University of Distance Education (UNED in its Spanish acronym). Further, the study was conducted in accordance with the latest declaration of Helsinki (Bošnjak, 2001; Tyebkhan, 2003; World Medical Association [WMA], 2022).

In order to distribute the information among their students and teachers, 1 month before starting the program, they contacted music colleges in different areas of Spain. Details were given of what the program consisted of, how it would be developed and the form to be completed by the participants was attached.

Some personal and sociodemographic data were requested in the form and the three scales were included to evaluate the variables of interest. It was suggested that the completion of the questionnaire evaluating FS should be done after carrying out a public performance (audition or concert) or to respond to this questionnaire considering the last performance or audition performed as a performative situation. In the case of post-test measures, EG responded to the form after carrying out a self-organized public performance (audition or concert) or using a performance planned in their schedule, but under criteria established in the program (see **Supplementary Material 2**). While CG responded to the post-test form on the same dates as EG after a concert or audition according to the usual course of their schedules.

Objectives and Contents of the Implemented Program

The Self-Regulation Skills for Performing Musicians (HAMI in its Spanish acronym) program was designed for participants to complete through the online platform Classroom (by Google). A combined approach was used, that is, they carried out the activities independently, but with contact and individualized feedback from the psychologist responsible for the program through the same platform. The program lasted 12 weeks where, on each school day, between 3 and 20 min had to be spent carrying out a task. In absolute terms, there were 60 days in the program.

The program's objectives were to have a direct impact on each of the components of Flow (see **Table 2**), and also on related factors (emotional awareness and regulation; interpersonal relationships; values; personal and social well-being; attention; memory; and social support).

Different exercises were carried out to develop the self-regulation skills that made up the program's objective. These exercises were designed from the evidence of different strands of scientific psychology. Specifically, from CBT (Farmer and Chapman, 2016; Gross, 2020), Mindfulness (Shapiro, 2020), Emotion Regulation Therapy (Gross, 2015; Renna et al., 2018), from its own research in Flow Theory (Jackson and Csikszentmihalyi, 1999), States of Optimal Experience (Sinnamon, 2020), and Positive Psychology (Biswas-Diener, 2010; Froh and Parks, 2013; Rashid and Seligman, 2018). The exercises were grouped into four sections (a) emotional and social awareness and regulation, (b) mindfulness exercises, (c) practice and performance preparation exercises, and (d) regulation exercises that, once grasped, are quickly implemented (such as breathing techniques or regulation through the senses) (to see the contents in detail, consult **Supplementary Material 2**). As mentioned above, each day an exercise was presented, and a total of 60 were performed. They were ordered taking into account the difficulty and were alternated so that exercises from each section appeared regularly.

TABLE 2 | Objectives related to components of Flow theory that were intended to be achieved with participation in the implemented program.

Balance	Understand the need for a sufficient level of technical competence in relation to the challenges to be faced.
	Adjust the challenges to personal skills and the situations in which those skills have to be used.
	Transform environments into more challenging ones, deliberately creating an obstacle.
Goals	Set clear goals during study, practice or performance.
	Structure environments to promote different objectives.
	Practice displaying the performance in advance.
	Establish a routine that facilitates reaching the optimal performance experience.
Feedback	Pay attention to your own goals, your own progress, and avoid comparisons.
	Learn to pay attention to the performance.
	Listen to clear feedback to stay tuned to the performance.
	Filter the feedback to keep the valuable information that links to the task.
	Establish a positive and energetic internal dialogue.
Concentration	Organize time to concentrate without disruption to the performance.
	Gradually increase concentration time.
	Learn to listen, observe, evaluate, carefully tune in to the performance.
	Learn to regain focus on the performance.
	Choose and practice the response and reaction that you can have yourself in the face of a distraction, a mistake or any setback.
Merging	Automate skills.
	Learn to pay attention to the body.
	Connect emotion and expression to movement.
Consciousness	Find out what happens to your attention when you become fully immersed in the performance.
	Train your mind in the present moment.
	Pay less attention to your image and the desire to impress.
	Learn to silence everyday issues and concerns.
	Work on and face criticism.
	Foster empathy and positive relationships (to reduce risk).
Control	Learn about the important factors that lead to optimal performance.
	Differentiate between what can and cannot be controlled.
	Create opportunities to display and improve the performance.
	Work on self-confidence.
Autotelic	Recall and reproduce FS experiences.
	Encourage enjoyment as part of the activity.
	Organize practice, study, and commitments so as to avoid burnout.
	Benefit from optimal preparation in different skills, such as technical-performance, mental, psychological, etc.

Statistical Analysis

To determine the degree of association between the variables, correlational analyses were performed. To test the assumptions of the quasi-experimental design, multi-group analyses were performed with structural equation modeling (SEM) (Holgado-Tello et al., 2016). The models of the FS, MPA, and SS variables were analyzed in order to establish the factorial and measurement invariance between EG and CG in the pre-test measures. The Generalized Least Squares (GLS) estimation method was used. On the other hand, in order to choose the appropriate

statistical method to perform the pre-post- and cross-group contrasts, normality tests were performed with significance tests and graphs. Normality assumptions were verified in all the variables. To determine if there were differences between the two groups and between the two temporary measures (pre–post), repeated measures mixed ANOVA and also contrasts for samples related to the Student's *t*-test were performed. In all cases, the Levene test was performed to verify the assumption of homoscedasticity of the variances of the two groups and was carried out in all the contrasts except those indicated ([a]). Statistical analyses were performed with LISREL 11 (Jöreskog and Sörbom, 2021), PRELIS (Jöreskog and Sörbom, 2021), SPSS for Windows v.25, and G*Power 3.1.9.2 (Erdfelder et al., 1996; Faul et al., 2007).

RESULTS

Demographic Analysis of Completer Versus Non-completers

Initially, 91 performing musicians accessed the program. Thirty-one were discarded shortly after starting the program because they did not give any sign of following it, they neither marked the tasks nor established any type of communication with the person in charge of the program. One of the explanations for this behavior would be that they were people interested in seeing the program rather than participating. On the other hand, throughout the program, 32 musicians didn't follow the pace that had been established to do the tasks and did not finish the program on time. However, it cannot be said that they abandoned it, they remained in the program to do it at their own pace, but they did not enter the investigation. Finally, 28 (EG) participants completed the proposed program and completed the subsequent forms that were considered for data analysis.

A demographic analysis of program completers versus non-completers was conducted to assess their future suitability. **Table 3** shows the percentages of participants (completers and non-completers) based on the categorical variables collected. The most relevant data is the highest percentage of completers in the string group (62.5%). In addition, musicians who did not play classical music completed the program in a lower percentage (7.7%).

TABLE 3 | Percentage of completers (C) versus non-completers (NC) according to the categorial variables considered.

Variable	Categories	% C ($n = 28$)	% NC ($n = 63$)
Gender			
	Men ($n = 32$)	28.1%	71.9%
	Women ($n = 59$)	32.2%	67.8%
Work			
	Student ($n = 58$)	32.8%	67.2%
	Professor ($n = 33$)	27.3%	72.7%
Musical style			
	Classical ($n = 79$)	34.6%	65.4%
	Other ($n = 12$)	7.7%	92.3%
Musical instrument			
	Woodwind ($n = 16$)	12.5%	87.5%
	Piano ($n = 26$)	26.9%	73.1%
	Singer ($n = 18$)	22.2%	77.8%
	Strings ($n = 16$)	62.5%	37.5%
	Other ($n = 15$)	33.3%	66.7%

N = 91.

TABLE 4 | Kolmogorov–Smirnov normality test.

Variables	Mean (*SD*)	*D*	*p*-value
FS	149.79 (39.85)	0.09	0.20
MPA	138.06 (33.92)	0.07	0.20
SS	33.08 (8.18)	0.08	0.20
Merging	24.52 (8.19)	0.10	0.20
Concentration	26.73 (8.27)	0.14	0.00
Control	24.39 (7.77)	0.07	0.20
Consciousness	20.56 (11.00)	0.10	0.20
Time	25.63 (10.61)	0.12	0.04
Autotelic	27.07 (9.58)	0.14	0.00

Descriptive Statistics

In general terms, standardized values of skewness and kurtosis out of the range –2 to 2 could be indicating significant deviation from normality (Jöreskog and Sörbom, 1993). The majority of the items presented negative skewness, and all of them were in the range –2 to 2. However, two items (MPA7 and MPA40), presented a high kurtosis.

On the other hand, the Kolmogorov–Smirnov test showed that the EF, AEM, HHSS and the subscales of EF (merging, control, and consciousness), were normally distributed. However, this result was not found in concentration, time and autotelic (see **Table 4**).

Bivariate and Partial Correlations Between Flow State, Musical Performance Anxiety, and Social Skills

Table 5 shows the Pearson correlations between the three dependent variables in the pre-test measures. Correlations between each pair of variables showed statistically significant median associations ($p < 0.01$). The correlation between FS and MPA showed a coefficient of $r = -0.40$; between FS and SS of $r = 0.45$; and MPA and SS of $r = -0.61$. These correlations remained relatively stable with slight variations in the post-test measures ($r = -0.54$, $r = 0.30$, and $r = -0.55$, respectively). Although, if we look at the size of the effect of the correlations (Cohen, 1988), in the pre-test the first two maintained medium effects while the last one had a high effect size. This situation is modified in the post-test, where the correlations between FS and MPA; and between MPA and SS present high effect sizes, while the FS-SS correlation remains at medium levels.

Table 6 shows the pre-and post- partial correlations between each pair of variables, keeping the third controlled. The correlations show that when the impact of SS is controlled,

TABLE 5 | Pearson correlations between FS, MPA, SS (pre-test measures).

	FS	MPA	SS
FS	1		
MPA	–0.395**	1	
SS	0.448**	–0.605**	1

***p < 0.01.*

TABLE 6 | Partial correlations (pr) in the pre- and post-measures.

Control variable	Primary variables	pr (pre)	pr (post)
FS	SS-MPA	–0.521***	–0.486***
MPA	FS-SS	0.286*	0.005
SS	FS-MPA	–0.174	–0.472***

**p < 0.05; ***p < 0.00.*

the correlation between FS and MPA decreases with respect to the bivariate correlations (see **Table 5**) and is no longer statistically significant in the pre-measure (pr = –0.17); however, in the post-measure, the relationship is moderate and statistically significant (pr = –0.47). When the impact of MPA is controlled, the correlation between FS and SS decreases with respect to the bivariate correlations (see **Table 5**) but remains statistically significant in the pre-measure (pr = 0.29); however, in the post-measure, the relationship between the two variables largely disappears (pr = 0.01). It is possible that practicing exercises aimed at promoting FS and coping with MPA had an effect on EG. Specific components of FS were increased but these effects were independent of SS. Finally, when the FS effect is controlled, the correlations between SS and MPA decrease slightly with respect to the bivariate correlations (see **Table 5**) and continue to be statistically significant both in the pre- (pr = –0.52) and post- (pr = –0.49).

Factorial and Measurement Invariance Between Groups

Table 7 shows the overall goodness-of-fit indices of the factor equivalence model and the measurement equivalence between groups in the pre-test measure for the FS, MPA, and SS variables. The values show that the two models, both the equal factor model and the measurement equality model, are invariant between EG and CG in the pre-test measure of FS, MPA, and SS. All overall goodness-of-fit indices show adequate values. That is, we find the same structure in both, and the relationship of each factor with its general factor (FS, MPA, and SS), is equivalent.

On the other hand, the values in the chi-square increment were not statistically significant, showing that the saturation matrix of both groups is equivalent in the three variables. Therefore, regarding the equivalence of the control and EGs in the pre-test condition, we have to accept the hypothesis that both groups are invariant.

Between-Subject Comparisons

The FS, MPA, and SS variables and the six dimensions of FS were analyzed. The ANOVA results in the pairwise comparisons of the between-subject effects tests of the pre-test measures did not show statistically significant differences between EG and CG; except MPA which did show differences [$F(1,60) = 3.94$, $p = 0.05$, $\eta 2 = 0.06$] (see **Table 8**).

In the post-measures, the between-subject effects showed statistically significant differences between CG and EG in the variables FS [$F(1,60) = 6.45$, $p = 0.01$, $\eta 2 = 0.10$] and MPA [$F(1,60) = 11.70$, $p = 0.00$, $\eta 2 = 0.16$], but not in SS [$F(1,60) = 2.03$, $p = 0.16$, $\eta 2 = 0.03$]. In the FS dimensions, there were statistically significant differences between the two groups in the post-merging measures [$F(1,60) = 4.61$, $p = 0.04$, $\eta 2 = 0.07$], concentration [$F(1,60) = 3.88$, $p = 0.05$, $\eta 2 = 0.06$] control [$F(1,60) = 6.67$, $p = 0.01$, $\eta 2 = 0.10$], and consciousness [$F(1,60) = 16.18$, $p = 0.00$, $\eta 2 = 0.21$]; but not in time [$F(1,60) = 0.31$, $p = 0.58$, $\eta 2 = 0.01$], nor in autotelic [$F(1,60) = 3.26$, $p = 0.08$, $\eta 2 = 0.05$] (see **Table 8**).

Within-Subject Effects and Comparisons for Related Samples

The ANOVA results in the within-subjects effects tests showed, on the one hand, a statistically significant increase in FS over time (pre-post) [$F(1,60) = 4.23$, $p = 0.04$, $\eta 2 = 0.07$], and a statistically significant interaction between the group and time [$F(1,60) = 6,12$, $p = 0.02$, $\eta 2 = 0.09$]. As for MPA, there was a statistically significant decrease over time [$F(1,60) = 5.56$, $p = 0.02$, $\eta 2 = 0.09$], and a statistically significant interaction between the group and time [$F(1,60) = 8.71$, $p = 0.01$, $\eta 2 = 0.13$].

TABLE 7 | Overall goodness-of-fit indices for the multi-group analysis (EG, CG) in the pre-test measure for the Flow, MPA, and SS variables.

Variable	Model	X^2	df	*p*	ECVI	RMSEA	NNFI	CFI
FS	Invariancefactors	16.98	18	0.52	1.10	0	1.11	1
	Measurement invariance	18.08	23	0.75	1.02	0	1.42	1
	X^2 increase	1.1	5	0.95				
MPA	Invariancefactors	71.03	70	0.44	2.52	0.02	0.86	0.89
	Measurement invariance	73.45	79	0.66	2.35	0	1.69	1
	X^2 increase	2.42	9	0.98				
SS	Invariancefactors	123.73	130	0.64	3.90	0	1.68	1
	Measurement invariance	141.03	142	0.51	3.70	0	1.10	1
	X^2 increase	17.3	12	0.13				

TABLE 8 | Descriptive statistics and ANOVA test.

		M (*SD*)		*F*	*p*	η^2	1-β
		EG	CG				
FS	PRE	153.14 (7.57)	147.03 (6.87)	0.36	0.55	0.01	0.09
	POST	171.64 (7.68)	145.32 (6.97)	6.45	0.01	0.10	0.71
MPA	PRE	128.86 (33.00)	145.65 (33.23)	3.94	0.05	0.06	0.50
	POST	117.54 (31.80)	146.38 (34.05)	11.70	0.00	0.16	0.92
SS	PRE	34.14 (7.90)	32.21 (8.41)	0.86	0.36	0.01	0.15
	POST	35.75 (8.04)	32.62 (9.05)	2.03	0.16	0.03	0.29
Merging	PRE	[(a)]25.86 (6.53)	[(a)]23.41 (9.30)	1.38	0.25	0.02	0.21
	POST	28.68 (6.51)	24.53 (8.34)	4.61	0.04	0.07	0.56
Concentration	PRE	27.82 (8.06)	25.82 (8.45)	0.90	0.35	0.02	0.15
	POST	30.21 (7.25)	26.29 (8.22)	3.88	0.05	0.06	0.50
Control	PRE	25.04 (7.86)	23.85 (7.77)	0.35	0.56	0.01	0.09
	POST	28.89 (7.04)	23.38 (9.31)	6.67	0.01	0.10	0.72
Consciousness	PRE	21.14 (11.35)	20.09 (10.85)	0.14	0.71	0.00	0.07
	POST	28.71 (8.28)	18.71 (10.80)	16.18	0.00	0.21	0.98
Time	PRE	24.79 (10.79)	26.32 (10.57)	0.32	0.57	0.01	0.09
	POST	24.36 (11.09)	25.91 (10.86)	0.31	0.58	0.01	0.09
Autotelic	PRE	28.50 (9.00)	27.53 (10.12)	0.16	0.70	0.00	0.07
	POST	30.79 (7.12)	26.50 (10.76)	3.26	0.08	0.05	0.43

Between-subject factors/pairwise comparison; g.l. = 1.60. Variables: Flow, MPA, SS and the six dimensions of Flow. EG, n = 28; CG, n = 34.
M, mean; SD, standard deviation; η^2, partial eta squared; 1-β, statistical power.
[a]*Significant Levene's test.*

Regarding the SS variable, there was no statistically significant difference over time [$F(1,60) = 3.37$, $p = 0.07$, $\eta2 = 0.05$], nor was there a statistically significant interaction between the group and time [$F(1,60) = 1.18$, $p = 0.28$, $\eta2 = 0.02$] (see **Table 9**).

Regarding the six dimensions of FS, "merging" showed a statistically significant increase over time [$F(1,60) = 4.28$, $p = 0.04$, $\eta2 = 0.07$], however, it did not show a statistically significant interaction between the group and time [$F(1,60) = 0.80$, $p = 0.37$, $\eta2 = 0.01$]; in the "concentration" dimension, there was no statistically significant difference over time [$F(1,60) = 3.02$, $p = 0.09$, $\eta2 = 0.05$], nor was there a statistically significant interaction between the group and time [$F(1,60) = 1.36$, $p = 0.25$, $\eta2 = 0.02$]. Regarding the "control" dimension, it showed a statistically significant increase over time [$F(1,60) = 3.86$, $p = 0.05$, $\eta2 = 0.06$], and a statistically significant interaction between the group and time [$F(1,60) = 6.31$, $p = 0.02$, $\eta2 = 0.10$]. Regarding the "consciousness" dimension, it showed a statistically significant increase over time [$F(1,60) = 5.90$, $p = 0.02$, $\eta2 = 0.09$], and a statistically significant interaction between the group and time [$F(1,60) = 12.36$, $p = 0.00$, $\eta2 = 0.17$]. Finally, in the "time" and "autotelic" dimensions, there were no statistically significant differences over time, nor was there a statistically significant interaction between the group and time (see **Table 9**).

Experimental Group

Student's *t*-tests for related samples showed statistically significant differences before and after the intervention in FS [$t(27) = -2.41$, $p = 0.02$, $d = 0.36$, 1-β = 0.45], MPA [$t(27) = 2.64$, $p = 0.01$, $d = 0.24$, 1-β = 0.24], "control" [$t(27) = -2.48$, $p = 0.02$, $d = 0.47$, 1-β = 0.67], and "consciousness" [$t(27) = -3.66$, $p = 0.00$, $d = 0.70$, 1-β = 0.94]. Therefore, there is sufficient evidence to conclude that the participants in the program showed higher levels of FS and lower levels of MPA after their participation in the program.

Control Group

Regarding the CG results, they did not show statistically significant differences in FS [$t(33) = 0.44$, $p = 0.66$, $d = 0.08$, 1-β = 0.07], MPA [$t(33) = -0.25$, $p = 0.81$, $d = 0.02$, 1-β = 0.05], "control" [$t(33) = -0.52$, $p = 0.61$, $d = 0.09$, 1-β = 0.08], nor in "consciousness" [$t(33) = 0.89$, $p = 0.38$, $d = 0.15$, 1-β = 0.14]. Therefore, there is sufficient evidence to accept the fourth hypothesis of the research, which stated that CG will not show differences between the pre-and post-measures of any of the variables considered.

DISCUSSION

For One of the most common and specific problems for performing musicians is MPA. According to Flow theory, it has been noted that anxiety could have a negative relationship with FS (Csikszentmihalyi, 1975, 1990; Csíkszentmihályi, 1997), which has led to the suggestion that interventions to promote FS could contribute to the reduction of MPA and facilitate musical performance (Lamont, 2012; Wrigley and Emmerson, 2013; Iusca, 2015; Cohen and Bodner, 2019a).

Flow state is a widely researched construct in different fields, especially in the field of Sport Psychology (cf. Jackman et al., 2019). In the field of music, there are more and more

TABLE 9 | Descriptive statistics and ANOVA test.

		M (SD)		*F*	*p*	η^2	1-β
		Pre	Post				
FS	EG	153.14 (39.23)	171.64 (34.63)	6.12	0.02	0.09	0.68
	CG	147.03 (40.73)	145.32 (44.93)				
MPA	EG	128.86 (33.00)	117.54 (31.80)	5.56	0.02	0.09	0.64
	CG	145.65 (33.23)	146.38 (34.05)				
SS	EG	34.14 (7.90)	35.75 (8.04)	1.18	0.28	0.02	0.19
	CG	32.21 (8.41)	32.62 (9.05)				
merging	EG	[(a)] 25.86 (6.53)	28.68 (6.51)	0.80	0.37	0.01	0.14
	CG	[(a)] 23.41 (9.30)	24.53 (7.80)				
concentration	EG	27.82 (8.06)	30.21 (7.25)	1.36	0.25	0.02	0.21
	CG	25.82 (8.45)	26.29 (8.22)				
control	EG	25.04 (7.86)	28.89 (7.04)	6.31	0.02	0.10	0.70
	CG	23.85 (7.77)	23.38 (9.31)				
consciousness	EG	21.14 (11.35)	28.71 (8.28)	12.36	0.00	0.17	0.93
	CG	20.09 (10.85)	18.71 (10.80)				
time	EG	24.79 (10.79)	24.36 (11.09)	0.00	0.99	0.00	0.05
	CG	26.32 (10.57)	25.91 (10.79)				
autotelic	EG	28.50 (9.00)	30.79 (7.12)	2.54	0.12	0.04	0.35
	CG	27.53 (10.14)	26.50 (10.76)				

Within-subject factors/group-moment interaction; g.l. = 1, 60. Variables: Flow, MPA, SS and the six dimensions of Flow. EG, n = 28; CG, n = 34.
M, mean; SD, standard deviation; η^2, partial eta squared; 1-β, statistical power.
[a]*Significant Levene's test.*

studies focused on Flow and related to music education and/or musical performance (Custodero, 2002, 2005; Fritz and Avsec, 2007; Sinnamon et al., 2012; Fullagar et al., 2013; Marin and Bhattacharya, 2013; Wrigley and Emmerson, 2013; Iusca, 2015; Cohen and Bodner, 2019a,b; Moral-Bofill et al., 2020b). In fact, Flow theory provides a framework to promote a more positive and satisfying relationship with performing and preventing MPA.

To that end, the main objective of the present research was to evaluate the effects of an electronically implemented psychological program, aimed at performing musicians, and designed to promote, mainly, the state of Flow, through the development of self-regulation skills and coping with MPA.

To evaluate the results of the intervention program, the factorial and measurement invariance between EG and CG was first analyzed for the three dependent variables in the baseline measurements. The results showed equivalence between the two groups with adequate overall goodness-of-fit indices (see **Table 7**). This result added greater internal validity to the study since it bases the results on the possible differences between the groups in the baseline measurements of the three dependent variables, and these possible differences can be interpreted without ambiguity (Holgado-Tello et al., 2016).

The results showed that EG and CG were homogeneous in FS, SS, and the six dimensions of FS in baseline measurements, however, the musicians who participated in the intervention had, prior to it, a lower level of MPA than the musicians in CG (see **Table 8**). This baseline difference in MPA could be related to the fact that the EG musicians were involved in the intervention program for this research because they may have a greater interest in developing self-regulation skills for performance. Therefore, they may have previously been involved in developing these skills independently, or in other programs or processes. It could be that the participants who were involved in the intervention were more interested in doing it because of greater motivation to be performing musicians and this motivation could provoke the need for the musicians to develop psychological skills as well.

Regarding the bivariate correlations between the FS, MPA, and SS variables, the results showed statistically significant median associations between each of them (see **Table 5**), and they remained stable with slight variations in the post-test measures. As in previous studies (Kirchner et al., 2008; Fullagar et al., 2013; Stocking, 2013; Cohen and Bodner, 2019a; Moral-Bofill et al., 2022), FS and MPA showed a negative correlation ($r = -0.40$) that increased in the post-test measure ($r = -0.54$), strengthening the negative relationship between the two variables. However, in the partial correlations, in the pre-measures, the partial correlation between FS and MPA presented a weak, non-statistically significant association when the effect of SS was eliminated. In addition, the partial correlations showed that each association between each pair of variables was more or less influenced by the effect of a third, depending on the moment in time. In the post-measures varied with respect to the pre-measures, both in FS-MPA and in FS-SS. This result points to the intervention program's effect on FS-specific and MPA-related components (such as "control" and "consciousness") but independent of SS, which is reflected in the differences between the partial correlations of the pre-and the post; specifically, in the post-measure's increase between FS and MPA and, on the other hand, the decrease between FS and SS.

However, the stability of the partial correlation between MPA and SS in the two temporal measures suggests that the development of SS could contribute to reducing general social anxiety and factors of social phobia that, in turn, could be an advantage for coping with MPA, results that, on the other hand, would support studies that highlight the importance of SS in the context of music education and performance (Kemp, 1996; Gaunt and Hallam, 2009; Ascenso et al., 2017; Moral-Bofill et al., 2022).

Regarding the intervention program's effects on the FS, MPA, and SS levels of the participating musicians, the results showed that the increase that EG had experienced in FS levels was statistically significant, with a small to medium effect size ($d = 0.36$). Similarly, EG experienced a decrease in MPA that was also found to be statistically significant, with a small effect size ($d = 0.24$). It has already been mentioned that EG showed lower MPA levels than CG in the pre-measure. As mentioned above, this result could be related to a greater knowledge of psychological skills that the EG musicians could have developed prior to the intervention. However, although EG had shown lower MPA levels than CG in measures prior to the intervention, those levels decreased even more after the program. On the other hand, CG did not show statistically significant differences between the two temporal measures, neither FS nor MPA. Unlike the study by Cohen and Bodner (2019b), which did not find an improvement in Dispositional Flow measures, the present study did find that activities had an effect on both FS and MPA levels. One of the reasons given by the authors for not finding improvements in Flow was that they used the Flow predisposition scale. In this study, the Spanish validated Flow state scale (Moral-Bofill et al., 2020b) was used. In any case, it is necessary to mention that promoting FS means having an impact on a possible MPA decrease, since some of the components of FS, or components that are conditions for triggering FS, are close to factors related to anxiety, such as consciousness and control, or the need for clear feedback that increases the controllability of a situation. Therefore, MPA is expected to decrease when an intervention is designed to promote FS. In the same way, it is reasonable to think that designing intervention programs to improve MPA should have an impact on FS levels. In fact, the results of this research suggest the same.

Regarding the six components of FS, all pairs of means (pre/post) remained stable in the two temporal measurements in CG (see **Table 9**). However, the differences between the pre- and post- measures in EG in "control" and "consciousness" were statistically significant and showed a medium effect size for "control" ($d = 0.47$) and large for "consciousness" ($d = 0.70$) (Cohen, 1988). Regarding the rest of the FS components, although the mean values were higher after the intervention in EG in all dimensions (except in "time," a factor that repeatedly shows weak correlations in the investigations or lack of correlation with the rest of the FS dimensions; Jackson and Eklund, 2002; Fournier et al., 2007; Kawabata et al., 2008; Liu et al., 2012; Wrigley and Emmerson, 2013; Moral-Bofill et al., 2020b), they didn't show any statistically significant differences. However, the higher score in items of these dimensions as a whole should have contributed to the overall FS scale and the statistically significant increase in FS levels after the intervention. In this sense, intervention programs that affect the emotional, cognitive, and motor aspects (and their interaction) of all dimensions could contribute to increasing the levels of the overall FS scale; for example, experiencing enjoyment inside and outside musical performance activity, improving attention and concentration, automating skills or regulating and expressing emotions in a way that facilitates the performance rather than hindering it, are elements that, in a summative way, could contribute to achieving the Flow experience.

On the other hand, these results could be linked to studies that suggest that FS dimensions could be grouped according to whether they refer to cognitive functions or emotional aspects (Stavrou and Zervas, 2004; Moral-Bofill et al., 2020b). In this regard, a study found that musicians who carried out some type of regular practice to cope with performing (psychological and/or body techniques from different strands of psychology) showed a statistically significant higher level of "concentration," "control," and "consciousness" than those who did not carry out any practice for that purpose. In addition, the magnitude of these differences in the measures of "control" and "consciousness" was important, above 0.50 and with good statistical power (>0.80). However, there were no differences in the rest of the dimensions (Moral-Bofill et al., 2022). The "concentration," "control," and "consciousness" dimensions would be more related to cognitive aspects, while the "merging," "time," and "autotelic" dimensions would reflect the sensations and emotions that arise from the Flow experience. We will return to this point later when the results of the "time" dimension are addressed.

In fact, this research's intervention program proposed tasks that could directly or indirectly potentially improve the cognitive dimensions; tasks to improve attention and concentration, tasks to regulate thoughts, fears, or self-criticism, tasks to develop self-confidence, emotional regulation exercises, etc. And, transversally, tasks were also proposed that promoted self-care, spending time enjoying various experiences (musical and everyday life), enhancing positive emotions, as well as positive relationships with others. But, as presented in the results, the dimensions that showed statistically significant differences were "control" and "consciousness." Although it may seem that the tasks intended to increase enjoyment were not effective, in reality, there is a possible explanation. It is difficult to assess whether and in what way these more cross-sectional tasks affected each of the FS dimensions, however, it is now recognized that emotional aspects have an influence on cognitive processes. Cognitive functions are facilitated by positive emotional states (Zull, 2006; Carew and Magsamen, 2010; Dolcos et al., 2011; Jung et al., 2014; Seli et al., 2016; Vogel and Schwabe, 2016; Tyng et al., 2017) (which is why emotional regulation techniques are considered central). Therefore, the benefits of these cross-sectional tasks or the emotional regulation tasks themselves, although not seen directly (for example, in a statistically significant increase in the post-test measure of "autotelic"), could be indirect effects on the cognitive dimensions. In other words, they could have a function of optimizing cognitive functions, in addition to directly influencing a possible increase in the enjoyment of the experience (statistically significant or not).

In any case, the results of this research show that the intervention program had a positive influence on these two FS (and strongly MPA-related) components, that is, on "control" and "consciousness." It has been suggested that "consciousness" plays an important role in achieving FS. Students who do not self-destructively criticize themselves achieve more Flow than those who have a self-destructive attitude (Kirchner et al., 2008). On the other hand, given the responsibility that performing musicians feel when they perform publicly, the emotional regulation that leads to an optimization of cognitive functions could probably contribute to the perceived control over the activity. And, if they feel in control of the situation and that they are mastering the task, their self-confidence will be boosted. In other words, the confidence one has in one's own resources to face a situation and achieve a desirable result. Because self-confidence is not a "blind" conviction, such as: "I'm sure it will work out," "I'm a champion," etc. but an internal state of psychological strength that implies a real knowledge of the difficulty that you face, one's own resources that can be used to achieve it, and, based on all that, the realistic possibilities that one has to achieve it (Buceta, 2020). Therefore, self-confidence would be based on the "perceived control" of the situations that are important for the performing musicians; and, in addition, the emotion of enjoyment is more likely to surface. Research on the brain basis of FS in the field of video games showed how activity changes in brain areas that are closely related to emotion and reward processing occurred in response to events characterized by a balance between skill and challenge. These changes in brain activity are a reflection of the rewarding effect of moments when the player masters the challenges of the game (Klasen et al., 2012), that is, when they experience a greater sense of control and mastery of the task.

It is necessary to mention the results of the "time" dimension separately. Of the six dimensions that make up FS, it is the one that showed more stable pre-post-measurements in EG (pre, $m = 24.79$; post, $m = 24.36$). In different research projects, "time" shows weak correlations with the rest of the dimensions (Jackson and Eklund, 2002; Fournier et al., 2007; Kawabata et al., 2008; Liu et al., 2012; Wrigley and Emmerson, 2013; Moral-Bofill et al., 2020b). What had not been found to date is that in an intervention program whose objective was to promote FS, after which the scores increased in five dimensions (statistically significant in two of them), the "time" dimension showed no change and the averages remained the same. It has been suggested that one of the important issues to investigate within Flow theory is whether time transformation is a consistent component of the optimal experience (Abuhamdeh, 2020). Apparently, the results of this research suggest that the "time" dimension may not be part of the Flow experience. However, the fact that it is not a consistent component, that is, it is not affected regularly across different contexts or people while the other dimensions are, or the possible changes in "time" do not occur in association with the rest of the dimensions, may be due to various factors that should be studied (Jackson and Eklund, 2004). In addition, for this research to be fruitful, it would be important to properly operationalize FS (Abuhamdeh, 2020). In the case of performing musicians and regarding the results obtained in this research, a suggestion could be made about the behavior of this variable. On the one hand, performing musicians (such as the participants in this study) who are pursuing higher education or who are active professionals, assume the consequences of their performance with great responsibility and need the optimization of cognitive functions to achieve a good performance level. One of the consequences of measuring FS (as in this study) through a scale with Likert-type responses, prevents detecting the point at which FS would be reached (Abuhamdeh, 2020). What can actually be said is that the particular effects were detected in each FS component. Therefore, it is possible that "time" (as a sensation of the Flow experience) was not affected by the completion of the program because, in reality, that state was not reached, but states close to the Flow experience were. As mentioned above, there is research that suggests that the dimensions of FS can be divided into cognitive ("concentration," "control," "consciousness") and sensory/emotional ("merging," "time," "autotelic"). Most likely, sensory/emotional dimensions (such as "time") may fully or partially emerge as a result of the optimization of cognitive dimensions. When the performing musicians face the performance they try to optimize their concentration, focus on what they are doing, and not worry about any other matter and control the situation. At the same time, they try to feel emotions that facilitate the performance. However, it is likely that, on many occasions, they will be unable to achieve an optimal experience during the activity and fully enjoy it. And yet, their performance is satisfactory and within the standards of a good performance (Sinnamon, 2020). So, in the case of this research, it would have to be said that the most significant effects of the intervention program are that a state of greater sense of control has been achieved, with disregard for what others may think. In addition, there was a more modest increase (statistically insignificant) in the levels of concentration, the sensation of action-awareness fusion, and autotelic experience, but not in the sensation of time transformation. All of this contributed to the fact that there was an increase in the overall FS scale in EG with a statistically significant difference after the intervention. However, it cannot be concluded that the state of Flow was fully achieved.

Regarding the SS variable, the results suggest that the activities that were designed to promote better interpersonal communication, self-confidence in social situations, empathy, and positive feelings toward others, did not cause changes in the SS of the participants (see **Table 9**). It should be noted that the program was not designed for the development of SS, but some activities that took these skills into account were contemplated. In addition, the implementation of the program coincided with the COVID-19 pandemic situation. Participants may have found fewer opportunities to socialize, interact spontaneously with others, and, ultimately, to best implement tasks aimed at building those skills. A notable fact is that the bivariate correlation between FS and SS (with the total number of participants, $N = 62$) in the post-measure decreased from 0.45 to 0.30; and, in the partial correlation, when the variance that FS and SS shared with MPA was removed, the correlation between the two variables (FS and SS) was basically zero. On one hand, the mean values of these two variables in CG remained the same between the pre- and post-measures (and the differences between them were not statistically significant). Instead, it was EG that showed a statistically significant increase in FS and only a slight non-significant increase in SS.

Therefore, this change in the post-correlation between the two variables (FS and SS) suggests that the FS level increased independently of SS. A future line of study regarding SS would be to study its relationship with FS and MPA through structural equation models that would permit an analysis of the type of effects that occur between these variables.

In summary, results indicated that the intervention significantly improved FS and decreased Music Performance Anxiety of the participants in the EG, but not CG. This suggests that programs whose designs incorporate a combination of all the techniques and methods that were used in the program and that come from scientific psychology could be useful to treat the problem of MPA or to prevent it; and, in addition, they could facilitate FS, greater enjoyment during a performance and potentially better performance quality. The results are consistent with the consideration of integrating various approaches of Psychology for the prevention or treatment of MPA, such as the psychology of emotion and emotional regulation, clinical psychology, performance psychology, and positive psychology (Kaleńska-Rodzaj, 2021).

Furthermore, through the electronic implementation, satisfactory results have been obtained. Although the program, which was carried out with programs whose objective is to treat depression (Andersson and Cuijpers, 2009), anxiety (Penate and Fumero, 2016) or stress management (Frazier et al., 2015; Heber et al., 2016, 2017) is not entirely comparable, the intervention program for the development of self-regulation skills in performing musicians showed efficacy in increasing FS and reducing MPA. One of the features of the programs with computerized treatments for depression and anxiety is that they improved with personalized support (Andersson and Cuijpers, 2009; Penate and Fumero, 2016), and this was a factor that was considered in the design of the program. On the other hand, a significant percentage of the participants in this research were music college students (68%). Although some web-based studies aimed at young people did not find clear evidence of the efficacy of these programs for the treatment of the symptoms of the most common mental disorders such as depression and anxiety (Reyes-Portillo et al., 2014; Taylor et al., 2021), other studies have shown small effect sizes for the treatment of depression, anxiety and stress (Harrer et al., 2019), and medium effects in skills training interventions for mental health prevention (Clarke et al., 2015; Conley et al., 2016). In addition, better results were also obtained when the participants had personalized support (Clarke et al., 2015; Conley et al., 2016).

Limitations

Limitations and possible future lines of research have already been discussed. But it is necessary to discuss the limitations regarding the generalization of the results because the selected sample is a target population chosen based on some characteristics, not selected randomly. Also, it needs to be emphasized that, the selection procedure was conditioned by the characteristics of working in "life itself" and not working in a research center. In fact, this study, more than usage research, offers the results of the evaluation of the implementation of a self-regulation skills training program. The investigation that was carried out is nothing other than the evaluation of that program. Another limitation is that 63 musicians who entered the program did not participate as planned. As mentioned in the results, about half showed no signs of following it and the other half did so at their own pace. Probably, the first ones were interested in seeing the program, but not doing it. However, in no case did they communicate that they wanted to leave it. In fact, they received the notification to perform the tasks every day until about the middle of the program. On the other hand, 32 musicians freely followed the program and expressed their interest in following it without the pressure of time. Therefore, it is possible that a longer time to complete the program means better results in terms of its completion.

It is also necessary to consider that no performance measures were taken. The pandemic situation complicated communication and collaboration with music institutions in order to take performance measures. But it would be especially interesting to take these measures since another issue that is not yet clear is whether the correlations between performance and FS are due to a good performance generating FS or a FS facilitating performance (Harris et al., 2021). However, this research would have to take on methodological challenges by inevitably posing causality hypotheses from an experimental approach. From the manipulation of factors, clear hypotheses about the processes involved, and direct measurement techniques to assess whether changes in predicted variables mediate the link between FS and performance (Harris et al., 2021).

Regarding the assessment of whether the program's specific design (including that it was carried out electronically) contributed to the improvements in FS and MPA, it is impossible to say. In order to prove it, it would have been necessary to compare it with other programs (which had been carried out by other groups of participants) and which differed in some element of the design, while controlling the other elements. For example, doing the program by dedicating each school day to carrying out some exercise, compared to doing the program by controlling all other factors, but doing one or two classes a week for the same amount of time. This could be a future line of research that would allow the analysis of whether daily regularity contributes to acquiring self-regulation skills more quickly and efficiently than practice which is more spaced out over time. Lastly, the participants had individualized support and feedback throughout the program (unscheduled). The platform was adjusted so that there was only individual interaction between each participant and the person in charge through private messages. However, the time each participant received from the responsible psychologist was not recorded. Taking this variable into account can improve future research.

Future Directions

Future research could study whether Internet-based programs with the aim of promoting FS (or in general, providing performing musicians with psychological tools for performance), show similar efficacy compared to face-to-face programs, as well as whether they present a greater (or lower) dropout rate. Or also, to introduce a third possibility in these studies, that is, the design of a program with a combination of the two (electronic and face-to-face). This line of research could be very interesting because elements can be introduced into the design

of the electronic intervention program which can be difficult to introduce into group face-to-face student classes (such as more personal and individualized attention or a scheduled daily practice approach). Likewise, the electronic program could also suffer from shortcomings, such as, for example, the hands-on practice of social skills in the classroom with classmates or the close contact (emotional and physical) of the professional in charge of the program. So a combination of the two possibilities (electronic and face-to-face) could be an advantage for the development of these skills. In any case, the presence of these psychological skills development programs in music schools seems necessary for the comprehensive education of performing musicians. Probably one of the most relevant reasons to promote the Flow response in performing musicians would be its relationship with subjective well-being and the quality of the experience during the performance. As long as the institutions and people responsible for educating musicians promote this experience, they will be addressing the need to enjoy the performing activity itself and promoting the mental health of the performing musicians (Moral-Bofill, 2021).

DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Department of Behavioral Sciences Methodology in the Faculty of Psychology at the National University of Distance Education (UNED) and were conducted in accordance with the latest declaration of Helsinki (World Medical Association [WMA], 2022). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LM-B: conceptualization, methodology, formal analysis, investigation, data curation, and writing – original draft preparation, review and editing. AL and MP-L: methodology, writing-original draft preparation, writing-review and editing, supervision, and project administration. FH-T: methodology, formal analysis, writing – review and editing, and supervision. All authors read and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.899621/full#supplementary-material

REFERENCES

Aalberg, A. L., Saksvik-Lehouillier, I., and Vaag, J. R. (2019). Demands and resources associated with mental health among Norwegian professional musicians. *Work* 63, 39–47. doi: 10.3233/WOR-192906

Abuhamdeh, S. (2020). Investigating the "flow" experience: key conceptual and operational issues. *Front. Psychol.* 11:158. doi: 10.3389/fpsyg.2020.00158

Altenmüller, E., Gruhn, W., Parlitz, D., and Liebert, G. (2000). The impact of music education on brain networks: evidence from EEG-studies. *Int. J. Music Educ.* 35, 47–53. doi: 10.1177/025576140003500115

Andersson, G., and Cuijpers, P. (2009). Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. *Cogn. Behav. Ther.* 38, 196–205. doi: 10.1080/16506070903318960

Andersson, G., and Titov, N. (2014). Advantages and limitations of Internet-based interventions for common mental disorders. *World Psychiatry* 13, 4–11. doi: 10.1002/wps.20083

Araújo, L. S., Wasley, D., Perkins, R., Atkins, L., Redding, E., Ginsborg, J., et al. (2017). Fit to perform: an investigation of higher education music students' perceptions, attitudes, and behaviors toward health. *Front. Psychol.* 8:1558. doi: 10.3389/fpsyg.2017.01558

Arnáiz, R. M. (2015). *La Interpretación Musical y la Ansiedad Escénica: Validación de un Instrumento de Diagnóstico y su Aplicación en los Estudiantes Españoles de Conservatorio Superior de Música (Tesis)*. A Coruña: Universidade da Coruña.

Ascenso, S., Williamon, A., and Perkins, R. (2017). Understanding the wellbeing of professional musicians through the lens of positive psychology. *Psychol. Music* 45, 65–81. doi: 10.1177/0305735616646864

Bakker, A. B. (2005). Flow among music teachers and their students: the crossover of peak experiences. *J. Vocat. Behav.* 66, 26–44. doi: 10.1016/j.jvb.2003.11.001

Bernhard, C. (2010). A survey of burnout among college music majors: a replication. *Music Perform. Res.* 3, 31–41.

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Musicae Sci.* 18, 189–202. doi: 10.1177/1029864914523282

Bisquerra, A. R. (2006). Orientacion psicopedagogica y educacion emocional. *Estudios Sobre Educ.* 11, 9–26.

Biswas-Diener, R. (2010). *Practicing Positive Psychology Coaching: Assessment, Activities, and Strategies for Success*. Hoboken, NJ: John Wiley & Sons.

Bošnjak, S. (2001). The declaration of Helsinki: the cornerstone of research ethics. *Arch. Oncol.* 9, 179–184.

Botella, C., Quero, S., Serrano, B., Baños, R. M., and García-Palacios, A. (2009). Avances en los tratamientos psicológicos: la utilización de las nuevas tecnologías de la información y la comunicación. *Anuario Psicol.* 40, 155–170.

Braden, A. M., Osborne, M. S., and Wilson, S. J. (2015). Psychological intervention reduces self-reported performance anxiety in high school music students. *Front. Psychol.* 6:195. doi: 10.3389/fpsyg.2015.00195

Brand, B. L., Schielke, H. J., Putnam, K. T., Putnam, F. W., Loewenstein, R. J., Myrick, A., et al. (2019). An online educational program for individuals with dissociative disorders and their clinicians: 1-year and 2-year follow-up. *J. Traumatic Stress* 32, 156–166. doi: 10.1002/jts.22370

Brodsky, W. (1996). Music performance anxiety reconceptualized: a critique of current research practices and findings. *Med. Probl. Performing Artists* 11, 88–98.

Brog, N. A., Hegy, J. K., Berger, T., and Znoj, H. (2022). Effects of an internet-based self-help intervention for psychological distress due to COVID-19: results of a randomized controlled trial. *Intern. Int.* 27:100492. doi: 10.1016/j.invent.2021.100492

Bryce, J., and Haworth, J. (2002). Wellbeing and flow in sample of male and female office workers. *Leis. Stud.* 21, 249–263.

Buceta, J. M. (2020). *Psicología del Deporte de alto Rendimiento*. Madrid: Dykinson.

Burak, S., and Atabek, O. (2019). Association of career satisfaction with stress and depression: the case of preservice music teachers. *J. Educ. Learn.* 8, 125–135.

Burin, A. B., and Osorio, F. L. (2017). Music performance anxiety: a critical review of etiological aspects, perceived causes, coping strategies and treatment. *Arch. Clin. Psychiatry (São Paulo)* 44, 127–133. doi: 10.1590/0101-60830000000136

Byrne, C., MacDonald, R., and Carlton, L. (2003). Assessing creativity in musical compositions: flow as an assessment tool. *Br. J. Music Educ.* 20, 277–290. doi: 10.1017/S0265051703005448

Carew, T. J., and Magsamen, S. H. (2010). Neuroscience and education: an ideal partnership for producing evidence-based solutions to guide 21 st century learning. *Neuron* 67, 685–688. doi: 10.1016/j.neuron.2010.08.028

Carli, M., Fave, A. D., and Massimini, F. (1988). "). The quality of experience in the flow channels: comparison of Italian and US students," in *Optimal Experience: Psychological Studies of Flow in Consciousness*, eds M. Csikszentmihalyi and I. S. Csikszentmihalyi (Cambridge: Cambridge University Press), 288,306.

Chirico, A., Serino, S., Cipresso, P., Gaggioli, A., and Riva, G. (2015). When music "flows". State and trait in musical performance, composition and listening: a systematic review. *Front. Psychol.* 6:906. doi: 10.3389/fpsyg.2015.00906

Clark, T., and Williamon, A. (2011). Evaluation of a mental skills training program for musicians. *J. Appl. Sport Psychol.* 23, 342–359. doi: 10.1080/10413200.2011.574676

Clarke, A. M., Kuosmanen, T., and Barry, M. M. (2015). A systematic review of online youth mental health promotion and prevention interventions. *J. Youth Adolesc.* 44, 90–113. doi: 10.1007/s10964-014-0165-0

Clarke, L. K., Osborne, M. S., and Baranoff, J. A. (2020). Examining a group acceptance and commitment therapy intervention for music performance anxiety in student vocalists. *Front. Psychol.* 11:1127. doi: 10.3389/fpsyg.2020.01127

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*, 2nd Edn. Mahwah, NJ: Lawrence Erlbaum Associates.

Cohen, S., and Bodner, E. (2019a). The relationship between flow and music performance anxiety amongst professional classical orchestral musicians. *Psychol. Music* 47, 420–435.

Cohen, S., and Bodner, E. (2019b). Music performance skills: a two-pronged approach–facilitating optimal music performance and reducing music performance anxiety. *Psychol. Music* 47, 521–538.

Conley, C. S., Durlak, J. A., Shapiro, J. B., Kirsch, A. C., and Zahniser, E. (2016). A meta-analysis of the impact of universal and indicated preventive technology-delivered interventions for higher education students. *Prev. Sci.* 17, 659–678. doi: 10.1007/s11121-016-0662-3

Crust, L., and Swann, C. (2013). The relationship between mental toughness and dispositional flow. *Eur. J. Sport Sci.* 13, 215–220. doi: 10.1080/17461391.2011.635698

Csikszentmihalyi, M. (1975). *Beyond Boredom and Anxiety*. Hoboken, NJ: Jossey-Bass.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. Manhattan, NY: Harper & Row.

Csikszentmihalyi, M. (1996). *Creativity: The Work and Lives of 91 Eminent People*. New York, NY: Harper Collins.

Csíkszentmihályi, M. (1997). *Finding Flow*. New York, NY: Basic.

Csikszentmihalyi, M. (2006). *Creatividad. El fluir y la psicología del descubrimiento y la invención*. Barcelona: Paidós.

Csikszentmihalyi, M., and Csikszentmihalyi, I. (1988). *Optimal Experience: Psychological Studies of Flow in Consciousness*. Cambridge: Cambridge University Press.

Csikszentmihalyi, M., and Lefevre, J. (1989). Optimal experience in work and leisure. *J. Pers. Soc. Psychol.* 56, 815–822. doi: 10.1037//0022-3514.56.5.815

Csikszentmihalyi, M., and Rich, G. (1998). "Musical improvisation: a systems approach," in *Creativity in Performance*, ed. K. Sawyer (Norwood, NJ: Ablex), 43–66.

Custodero, L. A. (2002). Seeking challenge, finding skill: flow experience and music education. *Arts Educ. Policy Rev.* 103, 3–9. doi: 10.1080/10632910209600288

Custodero, L. A. (2005). Observable indicators of flow experience: a developmental perspective on musical engagement in young children from infancy to school age. *Music Educ. Res.* 7, 185–209. doi: 10.1080/14613800500169431

Davidson, R. J. (2010). Empirical explorations of mindfulness: conceptual and methodological conundrums. *Emotion* 10, 8–11. doi: 10.1037/a0018480

Davidson, R. J., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S. F., et al. (2003). Alterations in brain and immune function produced by mindfulness meditation. *Psychosom. Med.* 65, 564–570. doi: 10.1097/01.PSY.0000077505.67574.E3

Détári, A., Egermann, H., Bjerkeset, O., and Vaag, J. (2020). Psychosocial work environment among musicians and in the general workforce in Norway. *Front. Psychol.* 11:1315. doi: 10.3389/fpsyg.2020.01315

Dobos, B., Piko, B. F., and Kenny, D. T. (2019). Music performance anxiety and its relationship with social phobia and dimensions of perfectionism. *Res. Stud. Music Educ.* 41, 310–326. doi: 10.1177/1321103X18804295

Dolcos, F., Iordan, A. D., and Dolcos, S. (2011). Neural correlates of emotion-cognition interactions: a review of evidence from brain imaging investigations. *J. Cogn. Psychol. (Hove, England)* 23, 669–694. doi: 10.1080/20445911.2011.594433

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., and Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: a meta-analysis of school-based universal interventions. *Child Dev.* 82, 405–432. doi: 10.1111/j.1467-8624.2010.01564.x

Egner, T., and Gruzelier, J. H. (2003). Ecological validity of neurofeedback: modulation of slow wave EEG enhances musical performance. *Neuroreport* 14, 1221–1224. doi: 10.1097/01.wnr.0000081875.45938.d1

Eisenberger, R., Jones, J. R., Stinglhamber, F., Shanock, L., and Randall, A. T. (2005). Flow experiences at work: for high need achievers alone? *J. Organ. Behav.* 26, 755–775. doi: 10.1002/job.337

Erdfelder, E., Faul, F., and Buchner, A. (1996). G*POWER: a general power analysis program. *Behav. Res. Methods Instr. Comput.* 28, 1–11. doi: 10.3758/BF03203630

Farmer, R. F., and Chapman, A. L. (2016). *Behavioral Interventions in Cognitive Behavior Therapy: Practical Guidance For Putting Theory Into Action*. Washington, DC: American Psychological Association.

Faul, F., Erdfelder, E., Lang, A. G., and Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* 39, 175–191. doi: 10.3758/BF03193146

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disord.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fishbein, M., Middlestadt, S. E., Ottati, V., Straus, S., and Ellis, A. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Probl. Perform. Art.* 3, 1–8.

Fournier, J., Gaudreau, P., Demontrond-Behr, P., Visioli, J., Forest, J., and Jackson, S. (2007). French translation of the Flow State Scale-2: factor structure, cross-cultural invariance, and associations with goal attainment. *Psychol. Sport Exerc.* 8, 897–916. doi: 10.1016/j.psychsport.2006.07.007

Frazier, P., Meredith, L., Greer, C., Paulsen, J. A., Howard, K., Dietz, L. R., et al. (2015). Randomized controlled trial evaluating the effectiveness of a web-based stress management program among community college students. *Anxiety Stress Coping Int. J.* 28, 576–586. doi: 10.1080/10615806.2014.987666

Fritz, B. S., and Avsec, A. (2007). The experience of flow and subjective well-being of music students. *Horiz. Psychol.* 16, 5–17. doi: 10.3389/fpsyg.2019.02115

Froh, J. J., and Parks, A. C. (2013). *Activities for Teaching Positive Psychology: A Guide for Instructors*. Washington, DC: American Psychological Association.

Fullagar, C. J., Knight, P. A., and Sovern, H. S. (2013). Challenge/skill balance, flow, and performance anxiety. *Appl. Psychol.* 62, 236–259. doi: 10.1111/j.1464-0597.2012.00494.x

Fung, H. W., Chan, C., Lee, C. Y., Yau, C., Chung, H. M., and Ross, C. A. (2020). Validity of a web-based measure of borderline personality disorder: a preliminary study. *J. Evid. Based Soc. Work* 17, 443–456. doi: 10.1080/26408066.2020.1760162

Gardner, H. E. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. New York, NY: Basic books.

Gaunt, H., and Hallam, S. (2009). "Individuality in the learning of musical skills," in *The Oxford Handbook of Music Psychology*, eds S. Hallam, I. Cross, and M. Thaut (Oxford: Oxford University Press), 274–284.

Gill, A. (2019). *Enhancing Music Performance Self-Efficacy Through Psychological Skills Training* Doctoral dissertation. Southbank, VIC: Melbourne Conservatorium of Music.

Ginsborg, J., Kreutz, G., Thomas, M., and Williamon, A. (2009). Healthy behaviours in music and non-music performance students. *Health Educ.* 109, 242–258. doi: 10.1108/09654280910955575

Gismero, E. (2010). *Escala de Habilidades Sociales*, 3 edición Edn. Madrid: TEA Ediciones.

Gour, S. (2018). Integration of technology with Google Classroom in higher education. *Int. J. Sci. Res. Comput. Sci. Eng. Inform. Technol.* 3, 1935–1939.

Gross, J. J. (ed.) (2015). *Handbook of Emotional Regulation*, 2nd Edn. New York, NY: Guilford.

Gross, R. D. (2020). *Psychology: The Science of Mind and Behaviour*. London: Hodder and Stoughton.

Harmat, L., de Manzano, Ö, and Ullén, F. (2021). "Flow in music and arts," in *Advances in Flow Research*, eds C. Peifer and S. Engeser (Cham: Springer), 377–391. doi: 10.1007/978-3-030-53468-4_14

Harrer, M., Adam, S. H., Baumeister, H., Cuijpers, P., Karyotaki, E., Auerbach, R. P., et al. (2019). Internet interventions for mental health in university students: a systematic review and meta-analysis. *Int. J. Methods Psychiatr. Res.* 28, 1–18. doi: 10.1002/mpr.1759

Harris, D. J., Allen, K. L., Vine, S. J., and Wilson, M. R. (2021). A systematic review and meta-analysis of the relationship between flow states and performance. *Int. Rev. Sport Exerc. Psychol.* 28:e1759. doi: 10.1080/1750984X.2021.1929402

Heber, E., Ebert, D. D., Lehr, D., Cuijpers, P., Berking, M., Nobis, S., et al. (2017). The benefit of web-and computer-based interventions for stress: a systematic review and meta-analysis. *J. Med. Intern. Res.* 19:e5774. doi: 10.2196/jmir.5774

Heber, E., Lehr, D., Ebert, D. D., Berking, M., and Riper, H. (2016). Web-based and mobile stress management intervention for employees: a randomized controlled trial. *J. Med. Intern. Res.* 18:e5112. doi: 10.2196/jmir.5112

Hoffman, S. L., and Hanrahan, S. J. (2012). Mental skills for musicians: managing music performance anxiety and enhancing performance. *Sport Exerc. Perform. Psychol.* 1, 17–28. doi: 10.1037/a0025409

Holgado-Tello, F., Chacón-Moscoso, S., Sanduvete-Chaves, S., and Pérez-Gil, J. A. (2016). A simulation study of threats to validity in quasi-experimental designs: interrelationship between design, measurement, and analysis. *Front. Psychol.* 7:897. doi: 10.3389/fpsyg.2016.00897

Holst, G. J., Paarup, H. M., and Baelum, J. (2012). A cross-sectional study of psychosocial work environment and stress in the Danish symphony orchestras. *Int. Arch. Occup. Environ. Health* 85, 639–649. doi: 10.1007/s00420-011-0710-z

Ingle, M. (2014). *Evaluation of a Trial of an e-Health Promotion Course Aimed at Australian Tertiary Music Students Thesis*. Sydney, NSW: Sydney Conservatorium of Music.

Iusca, D. (2015). The relationship between flow and music performance level of undergraduates in exam situations: the effect of musical instrument. *Proc. Soc. Behav. Sci.* 177, 396–400. doi: 10.1016/j.sbspro.2015.02.376

Jackman, P. C., Hawkins, R. M., Crust, L., and Swann, C. (2019). Flow states in exercise: a systematic review. *Psychol. Sport Exerc.* 45, 101546. doi: 10.1016/j.psychsport.2019.101546

Jackson, S. A., and Csikszentmihalyi, M. (1999). *Flow in Sports*. Champaign, IL: Human Kinetics.

Jackson, S. A., and Eklund, R. C. (2002). Assessing flow in physical activity: the flow state scale-2 and dispositional flow scale-2. *J. Sport Exerc. Psychol.* 24, 133–150. doi: 10.1123/jsep.24.2.133

Jackson, S. A., and Eklund, R. C. (2004). *The Flow Scales Manual*. Morgantown, WV: Fitness Information Technology.

Jöreskog, K. G., and Sörbom, D. (1993). *PRELIS 2: User's Reference Guide*. Chapel Hill, NC: Scientific Software International, Inc.

Jöreskog, K. G., and Sörbom, D. (2021). *LISREL 11*. Chapel Hill, NC: Scientific Software International, Inc.

Juncos, D. G., and de Paiva e Pona, E. (2018). Acceptance and commitment therapy as a clinical anxiety treatment and performance enhancement program for musicians: towards an evidence-based practice model within performance psychology. *Music Sci.* 1, 1–17. doi: 10.1177/2059204317748807

Jung, N., Wranke, C., Hamburger, K., and Knauff, M. (2014). How emotions affect logical reasoning: evidence from experiments with mood-manipulated participants, spider phobics, and people with exam anxiety. *Front. Psychol.* 5:570. doi: 10.3389/fpsyg.2014.00570

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: past, present, and future. *Clin. Psychol.* 10, 144–156.

Kaleńska-Rodzaj, J. (2021). Music performance anxiety and pre-performance emotions in the light of psychology of emotion and emotion regulation. *Psychol. Music* 49, 1758–1774. doi: 10.1177/0305735620961154

Karyotaki, E., Efthimiou, O., Miguel, C., Bermpohl, F. M. G., Furukawa, T. A., Cuijpers, P., et al. (2021). Internet-based cognitive behavioral therapy for depression: a systematic review and individual patient data network meta-analysis. *JAMA Psychiatry* 78, 361–371. doi: 10.1001/jamapsychiatry.2020.4364

Kawabata, M., Mallett, C. J., and Jackson, S. A. (2008). The flow state scale-2 and dispositional flow scale-2: examination of factorial validity and reliability for Japanese adults. *Psychol. Sport Exerc.* 9, 465–485.

Kegelaers, J., Schuijer, M., and Oudejans, R. R. (2021). Resilience and mental health issues in classical musicians: a preliminary study. *Psychol. Music* 49, 1273–1284. doi: 10.1177/0305735620927789

Keller, J., and Blomann, F. (2008). Locus of control and the flow experience: an experimental analysis. *Eur. J. Pers.* 22, 589–607. doi: 10.1128/AEM.02498-10

Kemp, A. E. (1996). *The Musical Temperament: Psychology and Personality of Musicians*. Oxford: Oxford University Press.

Kenny, D. (2011). *The Psychology of Music Performance Anxiety*. Oxford: Oxford University Press.

Kenny, D., and Ackermann, B. (2015). Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. *Psychol. Music* 43, 43–60. doi: 10.1177/0305735613493953

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T. (2005). A systematic review of treatments for music performance anxiety. *Anxiety Stress Coping* 18, 183–208. doi: 10.1080/10615800500167258

Kenny, D. T. (2009). "The factor structure of the revised Kenny music performance anxiety inventory," in *Proceeding of the International Symposium on Performance Science*, ed. A. Williamon (Utrecht: Association Européenne des Conservatoires), 37–41.

Kenny, D. T. (2010). "Negative emotions in music making: performance anxiety," in *Handbook of Music and Emotion: Theory, Research, Applications*, eds P. Juslin and J. Sloboda (Oxford: Oxford University Press), 425–451.

Kenny, D. T. (2016). Short-term psychodynamic psychotherapy (STPP) for a severely performance anxious musician: a case report. *J. Psychol. Psychother.* 6:272. doi: 10.4172/2161-0487.1000272

Kenny, D. T., and Ackermann, B. (2016). "Optimizing physical and psychological health in performing musicians," in *The Oxford Handbook of Music Psychology*, 2nd Edn, eds S. Hallam, I. Cross, and M. Thaut (Oxford: Oxford University Press), 390–400. doi: 10.1093/oxfordhb/9780198722946.013.38

Kenny, D. T., Arthey, S., and Abbass, A. (2014). Intensive short-term dynamic psychotherapy for severe music performance anxiety: assessment, process, and outcome of psychotherapy with a professional orchestral musician. *Med. Probl. Perform. Art.* 29, 3–7. doi: 10.21091/mppa.2014.1002

Kenny, D. T., Arthey, S., and Abbass, A. (2016). Identifying attachment ruptures underlying severe music performance anxiety in a professional musician undertaking an assessment and trial therapy of Intensive Short-Term Dynamic Psychotherapy (ISTDP). *SpringerPlus* 5, 1–16. doi: 10.1186/s40064-016-3268-0

Kenny, D. T., and Osborne, M. S. (2006). Music performance anxiety: new insights from young musicians. *Adv. Cogn. Psychol.* 2, 103–112.

Khalsa, S. B., Butzer, B., Shorter, S. M., Reinhardt, K. M., and Cope, S. (2013). Yoga reduces performance anxiety in adolescent musicians. *Altern. Ther. Health Med.* 19, 34–45.

Kim, Y. (2008). The effect of improvisation-assisted desensitization, and music-assisted progressive muscle relaxation and imagery on reducing pianists' music performance anxiety. *J. Music Ther.* 45, 165–191. doi: 10.1093/jmt/45.2.165

Kirchner, J. M., Bloom, A. J., and Skutnick-Henley, P. (2008). The relationship between performance anxiety and flow. *Med. Probl. Perform. Art.* 23, 59–65. doi: 10.21091/mppa.2008.2012

Klasen, M., Weber, R., Kircher, T. T., Mathiak, K. A., and Mathiak, K. (2012). Neural contributions to flow experience during video game playing. *Soc. Cogn. Affect. Neurosci.* 7, 485–495. doi: 10.1093/scan/nsr021

Klein, S. D., Bayard, C., and Wolf, U. (2014). The Alexander Technique and musicians: a systematic review of controlled trials. *BMC Complement. Altern. Med.* 14:414. doi: 10.1186/1472-6882-14-414

Kuester, A., Niemeyer, H., and Knaevelsrud, C. (2016). Internet-based interventions for posttraumatic stress: a meta-analysis of randomized controlled trials. *Clin. Psychol. Rev.* 43, 1–16. doi: 10.1016/j.cpr.2015.11.004

Kuhn, E., Kanuri, N., Hoffman, J. E., Garvert, D. W., Ruzek, J. I., and Taylor, C. B. (2017). A randomized controlled trial of a smartphone app for posttraumatic stress disorder symptoms. *J. Consul. Clin. Psychol.* 85, 267–273. doi: 10.1037/ccp0000163

Kuhnle, C., Hofer, M., and Kilian, B. (2012). Self-control as predictor of school grades, life balance, and flow in adolescents. *Br. J. Educ. Psychol.* 82, 533–548. doi: 10.1111/j.2044-8279.2011.02042.x

Lal, S., and Adair, C. E. (2014). E-mental health: a rapid review of the literature. *Psychiatr. Serv.* 65, 24–32. doi: 10.1176/appi.ps.201300009

Lamont, A. (2012). Emotion, engagement and meaning in strong experiences of music performance. *Psychol. Music* 40, 574–594. doi: 10.1177/0305735612448510

Lefevre, J. (1988). "Flow and the quality of experience during work and leisure," in *Optimal Experience: Psychological Studies of Flow in Consciousness*, eds M. Csikszentmihalyi and I. S. Csikszentmihalyi (Cambridge: Cambridge University Press), 307–318.

Liu, W., Liu, X., Ji, L., Watson, J. C., Zhou, C., and Yao, J. (2012). Chinese translation of the Flow-State SCale-2 and the Dispositional Flow Scale-2: examination of factorial validity and reliability. *Int. J. Sport Psychol.* 43:153.

Lupiáñez, M., de Paula Ortiz, F., Vila, J., and Muñoz, M. A. (2021). Predictors of music performance anxiety in conservatory students. *Psychol. Music* doi: 10.1177/03057356211032290 [Epub ahead of print].

MacDonald, R., Byrne, C., and Carlton, L. (2006). Creativity and flow in musical composition: an empirical investigation. *Psychol. Music* 34, 292–306. doi: 10.1177/0305735606064838

Marin, M. M., and Bhattacharya, J. (2013). Getting into the musical zone: trait emotional intelligence and amount of practice predict flow in pianists. *Front. Psychol.* 4:853. doi: 10.3389/fpsyg.2013.00853

Martin, A. J., and Jackson, S. A. (2008). Brief approaches to assessing task absorption and enhanced subjective experience: examining 'short'and 'core'flow in diverse performance domains. *Motiv. Emot.* 32, 141–157. doi: 10.1007/s11031-008-9094-0

Matei, R., Broad, S., Goldbart, J., and Ginsborg, J. (2018). Health education for musicians. *Front. Psychol.* 9:1137. doi: 10.3389/fpsyg.2018.01137

Moral-Bofill, L. (2021). "Desarrollo de la respuesta de Fluidez (Flow)," in *Psicología y Artes Escénicas*, eds A. LópezdelaLlave and M. C. Pérez-Llantada (Madrid: Dykinson), 205–228.

Moral-Bofill, L., Llave, A. L., and de la, and Pérez-Llantada, M. C. (2020a). Relationships between High Ability (Gifted) and flow in music performers: pilot study results. *Sustainability* 12:4289.

Moral-Bofill, L., Lópezdelallave, A., Pérez-Llantada, M. C., and Holgado-Tello, F. P. (2020b). Adaptation to Spanish and psychometric study of the Flow State Scale-2 in the field of musical performers. *PLoS One* 15:e0231054. doi: 10.1371/journal.pone.0231054

Moral-Bofill, L., Lópezdelallave, A., and Pérez-Llantada, M. C. (2022). "Influencia de las intervenciones psicológicas y/o corporales en la Fluidez y la Ansiedad Escénica Musical de los intérpretes de música," in *Investigaciones y Experiencias Profesionales en Psicología de las Artes Escénicas*, eds P. Blanco-Piñeiro, M. Zubeldia Echeberria, and A. López de la Llave Rodríguez (Madrid: Editorial UNED).

Moral-Bofill, L., Romero Naranjo, F. J., Albiar-Aliaga, E., and Cid-Lamas, J. A. (2015). The BAPNE method as a school intervention and support strategy to improve the school environment and contribute to socioemotional learning (SEL). *Int. J. Innov. Res. Educ. Sci.* 2, 450–456.

Mosing, M. A., Pedersen, N. L., Cesarini, D., Johannesson, M., Magnusson, P. K., Nakamura, J., et al. (2012). Genetic and environmental influences on the relationship between flow proneness, locus of control and behavioral inhibition. *PLoS One* 7:e47958. doi: 10.1371/journal.pone.0047958

Musgrave, G., and Gross, S. A. (2020). *Can Music Make You Sick?*. London: University of Westminster Press.

Nakamura, J., and Csikszentmihalyi, M. (2009). "Flow theory and research," in *The Oxford Handbook of Positive Psychology*, 2nd Edn, eds C. R. Snyder and S. J. López (Oxford: Oxford University Press), 195–206.

Norsworthy, C., Gorczynski, P., and Jackson, S. A. (2017). A systematic review of flow training on flow states and performance in elite athletes. *Graduate J. Sport Exerc. Phys. Educ. Res.* 6, 16–28.

Okmawati, M. (2020). The use of Google Classroom during pandemic. *J. Engl. Lang. Teach.* 9, 438–443. doi: 10.24036/jelt.v9i2.109293

Osborne, M. S. (2016). "Building performance confidence," in *The Child as Musician: A Handbook of Musical Development*, 2nd Edn, ed. G. McPherson (Oxford: Oxford University Press), 422–440.

Osborne, M. S., Greene, D. J., and Immel, D. T. (2014). Managing performance anxiety and improving mental skills in conservatoire students through performance psychology training: a pilot study. *Psychol. Well Being* 4, 1–17. doi: 10.1186/s13612-014-0018-3

Panebianco-Warrens, C. R., Fletcher, L., and Kreutz, G. (2015). Health-promoting behaviors in South African music students: a replication study. *Psychol. Music* 43, 779–792.

Peifer, C., and Wolters, G. (2021). "Flow in the context of work," in *Advances in Flow Research*, eds C. Peifer and S. Engeser (Berlin: Springer), 287–321.

Penate, W., and Fumero, A. (2016). A meta-review of Internet computer-based psychological treatments for anxiety disorders. *J. Telemed. Telecare* 22, 3–11. doi: 10.1177/1357633x15586491

Perkins, R., Reid, H., Araújo, L. S., Clark, T., and Williamon, A. (2017). Perceived enablers and barriers to optimal health among music students: a qualitative study in the music conservatoire setting. *Front. Psychol.* 8:968. doi: 10.3389/fpsyg.2017.00968

Rashid, T., and Seligman, M. (2018). *Positive Psychoterapy: Clinician Manual*. Oxford: Oxford University Press, doi: 10.1093/med-psych/9780195325386.001.0001

Rathunde, K., and Csikszentmihalyi, M. (2005). Middle school students' motivation and quality of experience: a comparison of Montessori and traditional school environments. *Am. J. Educ.* 111, 341–371.

Reger, M. A., and Gahm, G. A. (2009). A meta-analysis of the effects of Internet- and computer-based cognitive-behavioral treatments for anxiety. *J. Clin. Psychol.* 65, 53–75. doi: 10.1002/jclp.20536

Renna, M. E., Seeley, S. H., Heimberg, R. G., Etkin, A., Fresco, D. M., and Mennin, D. S. (2018). Increased attention regulation from emotion regulation therapy for generalized anxiety disorder. *Cogn. Ther. Res.* 42, 121–134. doi: 10.1007/s10608-017-9872-7

Reyes-Portillo, J. A., Mufson, L., Greenhill, L. L., Gould, M. S., Fisher, P. W., Tarlow, N., et al. (2014). Web-based interventions for youth internalizing problems: a systematic review. *J. Am. Acad. Child Adolesc. Psychiatry* 53, 1254–1270. doi: 10.1016/j.jaac.2014.09.005

Ríos-Lozada, R. N., Guevara-Fernández, J. A., Carranza-Dávila, R. G., Ramirez-Delgado, J. G., and Hernández-Fernández, B. (2022). Google classroom in educational service: a systematic review. *J. Posit. Sch. Psychol.* 6, 1634–1639.

Rotondi, A. J., Anderson, C. M., Haas, G. L., Eack, S. M., Spring, M. B., Ganguli, R., et al. (2010). Web-based psychoeducational intervention for persons with schizophrenia and their supporters: one-year outcomes. *Psychiatr. Serv.* 61, 1099–1105. doi: 10.1176/ps.2010.61.11.1099

Ryan, C. (2005). Experience of musical performance anxiety in elementary school children. *Int. J. Stress Manag.* 12, 331–342. doi: 10.1037/1072-5245.12.4.331

Santos, J. M. (2021). Google classroom: beyond the traditional setting. *Probl. Educ. 21st Century* 79, 626–639.

Schallberger, U., and Pfister, R. (2001). Flow-erleben in arbeit und freizeit. eine untersuchung zum "paradox der arbeit" mit der experience sampling method (ESM) [Flow experiences in work and leisure. An experience sampling study about the Paradox of Work]. *Zeitschrift Arbeitsund Organisationspsychologie* 45, 176–187. doi: 10.1026//0932-4089.45.4.176

Seli, P., Wammes, J., Risko, E., and Smilek, D. (2016). On the relation between motivation and retention in educational contexts: the role of intentional and unintentional mind wandering. *Psychon. Bull. Rev.* 23, 1280–1287. doi: 10.3758/s13423-015-0979-0

Seligman, M. (2008). Positive health. *Appl. Psychol.* 57, 3–18. doi: 10.1111/j.1464-0597.2008.00351.x

Shadish, W., Cook, T., and Campbell, T. D. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston, MA: Houghton Mifflin.

Shapiro, S. L. (2020). *Rewire Your Mind: Discover the Science and Practice of Mindfulness*. Dubai: Aster.

Sharda, P., and Bajpai, M. K. (2021). Online Learning and Teaching using Google Classroom during the COVID 19 Pandemic. *Desidoc J. Libr. Inform. Technol.* 41, 352–357. doi: 10.14429/djlit.41.5.16205

Shaw, T. A., Juncos, D. G., and Winter, D. (2020). Piloting a new model for treating music performance anxiety: training a singing teacher to use acceptance and commitment coaching with a student. *Front. Psychol.* 11:882. doi: 10.3389/fpsyg.2020.00882

Simblett, S., Birch, J., Matcham, F., Yaguez, L., and Morris, R. (2017). A systematic review and meta-analysis of e-mental health interventions to treat symptoms of posttraumatic stress. *JMIR Ment. Health* 4:e5558. doi: 10.2196/mental.5558

Sinnamon, S. (2020). *Achieving Peak Performance in Music: Psychological Strategies for Optimal Flow*. London: Routledge, doi: 10.4324/9781003037804

Sinnamon, S., Moran, A., and O'Connell, M. (2012). Flow among musicians: measuring peak experiences of student performers. *J. Res. Music Educ.* 60, 6–25.

Spahn, C. (2015). Treatment and prevention of music performance anxiety. *Prog. Brain Res.* 217, 129–140. doi: 10.1016/bs.pbr.2014.11.024

Spahn, C., Strukely, S., and Lehmann, A. (2004). Health conditions, attitudes toward study, and attitudes toward health at the beginning of university study: music students in comparison with other student populations. *Med. Probl. Perform. Art.* 19, 26–33. doi: 10.21091/mppa.2004.1005

Stavrou, N. A., and Zervas, Y. (2004). Confirmatory factor analysis of the Flow State Scale in sports. *Int. J. Sport Exerc. Psychol.* 2, 161–181. doi: 10.1080/1612197X.2004.9671739

Stocking, B. H. (2013). *Music Performance Anxiety and Dispositional Flow in Predicting Audition Success in Amateur Percussionists.* Master's thesis. Knoxville, TN: University of Tennessee.

Tan, L., and Sin, H. X. (2021). Flow research in music contexts: a systematic literature review. *Musicae Sci.* 25, 399–428. doi: 10.1177/1029864919877564

Tang, Y., and Ryan, L. (2020). Music performance anxiety: can expressive writing intervention help? *Front. Psychol.* 11:1334. doi: 10.3389/fpsyg.2020.01334

Taylor, C. B., Graham, A. K., Flatt, R. E., Waldherr, K., and Fitzsimmons-Craft, E. E. (2021). Current state of scientific evidence on Internet-based interventions for the treatment of depression, anxiety, eating disorders and substance abuse: an overview of systematic reviews and meta-analyses. *Eur. J. Public Health* 31(31Suppl_1), i3–i10. doi: 10.1093/eurpub/ckz208

Taylor, R. D., Oberle, E., Durlak, J. A., and Weissberg, R. P. (2017). Promoting positive youth development through school-based social and emotional learning interventions: a meta-analysis of follow-up effects. *Child Dev.* 88, 1156–1171. doi: 10.1111/cdev.12864

Teng, C. I. (2011). Who are likely to experience flow? Impact of temperament and character on flow. *Pers. Individ. Differ.* 50, 863–868. doi: 10.1016/j.paid.2011.01.012

Thurber, M. R., Bodenhamer-Davis, E., Johnson, M., Chesky, K., and Chandler, C. K. (2010). Effects of heart rate variability coherence biofeedback training and emotional management techniques to decrease music performance anxiety. *Biofeedback* 38, 28–40. doi: 10.5298/1081-5937-38.1.28

Triberti, S., Di Natale, A. F., and Gaggioli, A. (2021). "Flowing technologies: the role of flow and related constructs in human-computer interaction," in *Advances in Flow Research*, eds C. Peifer and S. Engeser (Berlin: Springer), 351–375.

Tyebkhan, G. (2003). Declaration of Helsinki: The ethical cornerstone of human clinical research. *Ind. J. Dermatol. Venereol. Leprol.* 69, 245–247.

Tyng, C. M., Amin, H. U., Saad, M. N. M., and Malik, A. S. (2017). The influences of emotion on learning and memory. *Front. Psychol.* 8:1454. doi: 10.3389/fpsyg.2017.01454

Ullén, F., de Manzano, Ö, Almeida, R., Magnusson, P. K., Pedersen, N. L., Nakamura, J., et al. (2012). Proneness for psychological flow in everyday life: associations with personality and intelligence. *Pers. Individ. Differ.* 52, 167–172. doi: 10.1016/j.paid.2011.10.003

Vaag, J., Bjerkeset, O., and Sivertsen, B. (2021). Anxiety and depression symptom level and psychotherapy use among music and art students compared to the general student population. *Front. Psychol.* 12:2337. doi: 10.3389/fpsyg.2021.607927

Vaag, J., Bjørngaard, J. H., and Bjerkeset, O. (2016). Symptoms of anxiety and depression among Norwegian musicians compared to the general workforce. *Psychol. Music* 44, 234–248. doi: 10.1177/0305735614564910

Vogel, S., and Schwabe, L. (2016). Learning and memory under stress: implications for the classroom. *NPJ Sci. Learn.* 1:16011. doi: 10.1038/npjscilearn.2016.11

Waters, L. (2011). A review of school-based positive psychology interventions. *Educ. Dev. Psychol.* 28, 75–90. doi: 10.1375/aedp.28.2.75

Williamon, A. (ed.) (2004). *Musical Excellence: Strategies and Techniques to Enhance Performance*. Oxford: Oxford University Press.

Williams, J. M. (ed.) (2010). *Applied Sport Psychology: Personal Growth to Peak Performance*. New York, NY: McGraw-Hill.

Woody, R. H., and McPherson, G. E. (2010). "Emotion and motivation in the lives of performers," in *Handbook OF Music AND Emotion: Theory, Research, Applications*, eds P. N. Juslin and J. A. Sloboda (Oxford: Oxford University Press), 401–424.

World Medical Association [WMA] (2022). *Declaración de Helsinki para la Investigación con Seres Humanos*. Available online at: https://www.wma.net/es/policies-post/declaracion-de-helsinki-de-la-amm-principios-eticos-para-las-investigaciones-medicas-en-seres-humanos/ (accessed August 27, 2022).

Wrigley, W. J., and Emmerson, S. B. (2013). The experience of the flow state in live music performance. *Psychol. Music* 41, 292–305. doi: 10.1177/0305735611425903

Zull, J. E. (2006). "Key aspects of how the brain learns," in *The Neuroscience of Adult Learning*, eds S. Johnson and K. Taylor (Hoboken, NJ: Jossey-Bass), 3–9.

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Classical Music Students' Pre-performance Anxiety, Catastrophizing, and Bodily Complaints Vary by Age, Gender, and Instrument and Predict Self-Rated Performance Quality

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Music performance anxiety (MPA) is a multifaceted phenomenon occurring on a continuum of severity. In this survey study, we investigated to what extent the affective (anxiety), cognitive (catastrophizing), and somatic (bodily complaints) components of MPA prior to solo performances vary as a function of age, gender, instrument group, musical experience, and practice as well as how these MPA components relate to self-rated change in performance quality from practice to public performance. The sample comprised 75 male and 111 female classical music university students, aged 15–45 years. Age was positively associated with anxious feelings and bodily complaints. Compared to male students, female students reported significantly more anxious feelings and catastrophizing. Singers reported less anxious feelings and catastrophizing than instrumentalists. Breathing-, mouth- and throat-related complaints were highest among singers and wind players; hand- and arm-related complaints were highest among string players and pianists. The indices of musical experience and practice had marginal effects. An average of four bodily complaints bothered the participants strongly to very strongly. Worsening in performance quality from practice to public performance was reported by almost half of the participants and was best predicted by anxious feelings and breathing-related complaints. We conclude that age, gender and instrument play a significant role in understanding the phenomenology of MPA. Musicians should be examined according to these characteristics rather than as one homogenous population. In particular, it might be valuable to develop assessment tools for MPA that incorporate items related to the bodily complaints that are most relevant to the different instrument groups. Breathing-related complaints could add

an important dimension to the investigation of MPA and music performance. Finally, the high percentage of students reporting worsening of their performance quality from practice to public performance highlights the need of professional support to help music students be able to perform at their best and thrive as artists.

Keywords: music performance anxiety, catastrophizing, bodily complaints, age, gender, musical instrument, musical experience, self-rated musical performance quality

INTRODUCTION

Music performance anxiety (MPA) is one of the leading problems among musicians with potential debilitating effects on musicians' career and health (Orejudo et al., 2018; Fernholz et al., 2019). MPA is a multifaceted phenomenon that can be understood in terms of affective, cognitive, physiological, and behavioral components (Kenny, 2010). A greater understanding of the predicting factors of MPA has implications not only for theories of MPA but also for its prevention and management and more broadly for teaching and learning. A first aim of this study was to investigate how age, gender, instrument group, and indices of musical experience and practice relate to three facets of MPA: anxious feelings, catastrophizing, and bodily complaints. Anxious feelings refer to the experience of tension, nervousness, apprehension, fear, dread, or panic (Steptoe, 2001). Catastrophizing is a form of worry consisting in the irrational exaggeration of the likelihood of disaster (Steptoe and Fidler, 1987; Liston et al., 2003). Bodily complaints refer to somatic symptoms such as racing heart and dry mouth (Shoup, 1995).

Children as young as three can experience some form of MPA (Boucher and Ryan, 2011), which appears to increase throughout childhood and adolescence (Osborne et al., 2005; Chan, 2011; Patston and Osborne, 2016; Dempsey and Comeau, 2019). Research on the association between age and MPA in adulthood has produced mixed findings. Whereas a few studies suggest that younger musicians may be more affected by MPA than older musicians (Huston, 2001; Osborne and Franklin, 2002; Kenny et al., 2014; Butkovic et al., 2021), others found no significant relationship between age and MPA (Wolfe, 1989; Wesner et al., 1990; van Kemenade et al., 1995; Liston et al., 2003; Kobori et al., 2011; Papageorgi et al., 2013; Dobos et al., 2019; Cohen and Bodner, 2021; Lupiáñez et al., 2021), and one study found a significant positive association between age and MPA in university-level music students (Zarza-Alzugaray et al., 2018).

We could locate approximately 45 studies that investigated gender differences in MPA. In line with the broader literature on anxiety (Bandelow and Michaelis, 2015), about two third of them found female musicians to report significantly higher levels of MPA than male musicians (e.g., Hildebrandt et al., 2012; Casanova et al., 2018; Coskun-Sentürk and Cirakoglu, 2018; Zarza-Alzugaray et al., 2020). About one third of the studies reported no significant gender differences in MPA (e.g., Kobori et al., 2011; Barbar et al., 2014).

With regard to the relationship between instrument and MPA, evidence suggests that (choral) singers may experience lower levels of MPA than (orchestral) instrumentalists (van Kemenade et al., 1995; Schröder and Liebelt, 1999; Sadler and Miller, 2010; Simoens et al., 2015; Robson and Kenny, 2017; Spahn et al., 2021; but see Iusca and Dafinoiu, 2012; Nusseck et al., 2015). Whether different groups of instrumentalists have significantly different levels of MPA is unclear (Fishbein and Middlestadt, 1988; Kenny et al., 2014; Zarza-Alzugaray et al., 2018; Cohen and Bodner, 2021). There is some evidence that instrument groups may differ in the experience of specific bodily complaints (Wolfe, 1989; Studer et al., 2011a), but no in-depth analysis on this issue exists.

Thousands of hours of lessons, practice and performing over many years are necessary to become a professional musician (Ericsson et al., 1993). Researchers have been interested in determining to what extent MPA varies as a function of measures of musical experience and practice. With regard to the amount of practice, studies have either found a significant negative association (Biasutti and Concina, 2014; González et al., 2018; Dobos et al., 2019) or no significant relationship (Kobori et al., 2011; Kenny et al., 2013; Sârbescu and Dorgo, 2014; Lupiáñez et al., 2021; Tan et al., 2021) with MPA. With regard to years studying/playing/performing, the findings are mixed. Studies found that number of years studying/playing/performing was either positively related (Osborne et al., 2005; Patston and Osborne, 2016), negatively related (Huston, 2001; Osborne and Franklin, 2002; Ryan and Andrews, 2009), or more often unrelated (Wolfe, 1989; van Kemenade et al., 1995; Rae and McCambridge, 2004; Sadler and Miller, 2010; Kobori et al., 2011; Kenny et al., 2013; Nusseck et al., 2015; Robson and Kenny, 2017; Casanova et al., 2018; González et al., 2018; Zarza-Alzugaray et al., 2018; Dobos et al., 2019) to MPA. Steptoe and Fidler (1987) found a negative association between years playing in public and MPA in professional orchestral musicians but not in music students and members of an amateur orchestra. With regard to the frequency of performances, the majority of studies suggest that increasing performance frequency is associated with decreasing MPA (Fehm and Schmidt, 2006; Sârbescu and Dorgo, 2014; Simoens et al., 2015; Casanova et al., 2018; Coskun-Sentürk and Cirakoglu, 2018; González et al., 2018; Zarza-Alzugaray et al., 2020; Lupiáñez et al., 2021; but see Huston, 2001; Nusseck et al., 2015). Finally, the literature suggests that music students' educational level and MPA are not significantly related (Kaspersen and Gotestam, 2002; Liston et al., 2003; Oudejans et al., 2017; Casanova et al., 2018; Lupiáñez et al., 2021).

A second aim of this study was to determine how the MPA components anxious feelings, catastrophizing, and bodily complaints relate to self-rated change in performance quality

from practice to public performance. Socially anxious individuals believe that their own abilities fall short of expected audience standards and rate their performance in socially evaluative situations more negatively than socially non-anxious individuals and more poorly than observers do (Rapee and Lim, 1992; Penney and Abbott, 2014). Negative performance appraisal as part of a negative self-appraisal is a main predictor of negative post-event rumination, all of which contribute to maintaining the cycle of social anxiety (Wong and Rapee, 2016). Similar phenomena have been observed among musicians (Osborne and Franklin, 2002; Nielsen et al., 2018). What role does MPA play with regard to the appraisal of one's own performance? Survey studies have shown that musicians believe that MPA affects their performance quality, with anxious musicians reporting more perceived impairment than non-anxious musicians (Wesner et al., 1990; Clark and Agras, 1991; van Kemenade et al., 1995; Schröder and Liebelt, 1999; Kokotsaki and Davidson, 2003; Fehm and Schmidt, 2006; Papageorgi et al., 2013). A negative association between MPA and either self-rated performance quality, perceived competence or self-reported level of achievement has been reported in studies assessing these concepts separately (Yoshie et al., 2008, 2009b; Chan, 2011; MacIntyre et al., 2012; González et al., 2018; Aufegger and Wasley, 2020). In this study, we wish to extend this line of work by exploring to what extent different facets of MPA predict self-rated change in performance quality from practice to public performance.

Researchers investigating what factors predict or are associated with MPA have used a broad range of tools to measure MPA, from single questions to multi-item questionnaires. However, it remains largely under-researched how age, gender, instrument type, experience, and practice are related to different facets of MPA, and how different facets of MPA are related to self-rated performance quality. A few studies suggest that the strength of these relationships may be dependent on the specific MPA component (Wolfe, 1989; Levy et al., 2011; Sârbescu and Dorgo, 2014; Butkovic et al., 2021; Cornett and Urhan, 2021). For instance, Levy et al. (2011) administered the Performance Anxiety Inventory (Nagel et al., 1981) to 780 world class drum and bugle corps performers and found that females reported more frequent cognitive symptoms than males did. In contrast, there was no significant gender difference for the somatic symptoms.

Solo performances induce higher levels of anxiety than ensemble performances (e.g., Nicholson et al., 2015), and manifestations of MPA before, during and after a performance are different (e.g., Studer et al., 2014; Spahn et al., 2021). If participants refer to different performance settings or different performance phases when reporting on their MPA, interpretation of the results within and between studies is complicated. Moreover, MPA differs as a function of the musical genre (Papageorgi et al., 2013). Contradictory findings in previous research might be partly due to not taking sufficiently into account or controlling for these aspects. In the present study, we control for these factors by investigating the affective, cognitive and somatic facets of MPA in a sample of classical music university students just prior to solo performances.

The first goal of this study was to investigate to what extent age, gender, instrument group, and four indices of musical experience and practice (i.e., academic year, years of instrument study, hours of daily practice, and number of solo performances during the last year) are significant predictors of three facets of MPA, i.e., anxious feelings, catastrophic thinking, and bodily complaints. We expected being female, being an instrumentalist and performing less frequently to be associated with more anxious feelings, catastrophizing, and bodily complaints than being male, being a singer and performing more frequently. Moreover, we hypothesized that instrument group would be a significant predictor of three sub-categories of bodily complaints. Specifically, breathing-related complaints and mouth- and throat-related complaints were expected to be most problematic for singers and wind players, whereas hand- and arm-related complaints were expected to be most problematic for string players and pianists. We predicted academic year to have no significant effects on any MPA components. Given the inconsistency of previous findings, we treated as exploratory issues whether age, years of instrument study and hours of daily practice have significant effects on the MPA components.

The second goal of this study was to investigate whether students' pre-performance anxious feelings, catastrophic thinking and bodily complaints are significant predictors of their self-rated change in performance quality from practice to public performance. We predicted that all MPA components would be positively associated with a worsening of the performance quality from practice to public performance when tested one by one. Which model would emerge as the best fitting model in multiple regression analysis was treated as an exploratory issue.

MATERIALS AND METHODS

Procedure and Participants

We collected the data presented in this article as part of a questionnaire survey on stage fright in students enrolled at the department of classical music of four universities in the French speaking part of Switzerland. We sent the questionnaire to the students by mail. The study was performed according to the principles of the 1964 Declaration of Helsinki and was approved by the local ethics committee. All students gave their informed written consent to participate. The questionnaire covered several themes, some of which were reported in Studer et al. (2011a,b). As explained in Studer et al. (2011b), we could assume that the sample was representative of the contacted student population.

Participants included in this study were 111 females and 75 males. Their age ranged from 15 to 45 years with a mean of 24.2 (SD = 4.3). The sample included 23 singers, 53 wind players, 59 string players, 40 pianists, and 11 percussionists. Four additional students filled in the questionnaire but were excluded from the analyses of this study because their instrument did not belong to one of these five instrument groups. Students' advancement in their education ranged from the 1st year to the 7th year with the following percentages of students for each year: 1st year: 28%; 2nd year: 29%; 3rd year: 20%; 4th year: 10%; 5th year: 5%; 6th year: 3%; 7th year: 5%. The number of years studying their instrument

ranged from 1 to 35 years, with a mean of 13.5 years (SD = 4.9). The average number of hours of daily practice ranged from 1 to 10 h with an average of 5 h (SD = 1 h and 48 min). Finally, the number of solo performances given in the last 12 months were as follows (percentage of students): 1–5: 38%; 6–10: 38%; 11–15: 11%; 16–20: 6%; 21–25: 1%; 26–30: 1%; 31–35: 1%; >35: 4%.

Questionnaires

Age, Gender, Instrument Group, Musical Experience, and Practice

Participants were asked to indicate their age in years, their gender (male or female), their main instrument and their current academic year since starting university-level education. They further answered the following three questions: (1) "How many years have you been practicing or studying your main instrument (including non-professional and pre-professional studies)?"; (2) "On average, how many hours do you devote to instrumental or vocal practice per day (main instrument and other instruments including personal work, lessons and rehearsals)?"; and (3) "In the last year (last 12 months), how many solo performances have you approximately given (auditions, concerts, exams, competitions, masterclasses, etc., with main instrument and other instruments)?" For the last question, participants had to choose one of the following answers: 1–5, 6–10, 11–15, 16–20, 21–25, 26–30, 31–35, >35. For the analyses, we coded these answers with numbers from 1 to 8.

Music Performance Anxiety Components

Participants filled in the following three questionnaires by referring to their experiences just prior to their recent solo performances. We assessed anxious feelings with the 20-item state scale of the State-Trait Anxiety Inventory (Spielberger, 1983; example items are "I feel nervous," "I feel frightened"). Participants rated each item on a 4-point scale (1 "not at all" to 4 "very much so"). The total score of this questionnaire ranges from 20 (no anxiety) to 80 (extreme anxiety). Following Spielberger's (1983) instructions, we excluded seven participants with missing values for three or more items. In case of one or two missing values, we replaced them by the mean of the other items and rounded up the sum to the next whole number. Cronbach's alpha in the present sample was 0.92. We measured catastrophizing with three items originally developed by Steptoe and Fidler (1987). These are "I do not feel in control of this situation; anything might happen," "I am almost sure to make a dreadful mistake, and that will ruin everything," and "I do not think I will be able to get through to the end without cracking up." Participants answered each item on a 5-point scale (0 "never," 1 "rarely," 2 "sometimes," 3 "often," 4 "very often"). The total score can range from 0 (no catastrophizing) to 12 (extreme catastrophizing). We excluded seven participants with missing values for one or more items. Cronbach's alpha in the present sample was 0.72. We assessed 29 bodily complaints selected from the Nijmegen Questionnaire (van Dixhoorn and Duivenvoorden, 1985), the Performance Anxiety Questionnaire (Cox and Kenardy, 1993) and interviews conducted with music students. Participants were asked to rate the discomfort associated with each complaint on a 5-point scale (0 "not at all," 1 "a little," 2 "moderate," 3 "strong," 4 "very strong"). For each participant, we computed a mean score of all bodily complaints. We exclude 12 participants with missing values for three or more bodily complaints. Cronbach's alpha was 0.86. For each participant, we also computed the number of severe complaints defined as the complaints with a strong or very strong level of discomfort. Finally, we computed mean scores for three sub-categories of bodily complaints: breathing-related complaints (five items), mouth- and throat-related complaints (four items), and hand- and arm-related complaints (five items). We excluded participants with missing values for two or more items (12 for breathing-related complaints; nine for mouth- and throat-related complaints and nine for hand- and arm-related complaints). Cronbach's alphas for these three sub-categories were 0.74, 0.71, and 0.72, respectively.

Self-Rated Change in Performance Quality From Practice to Public Performance

The participants completed the following sentence "When you play/sing in public (compared to when you play/sing alone without an audience), the quality of your performance is generally (a) worse, (b) rather worse, (c) neither worse nor better, (d) rather better, (e) better, (f) I do not know." Four participants did not answer this question. For the analysis of this variable, we attributed the scores 1 to "better," 2 to "rather better," 3 to "neither worse nor better," 4 to "rather worse," and 5 to "worse," so that higher scores correspond to a worsening of the performance quality from practice to public performance.

Statistical Analyses

We performed all statistical analyses using STATA version 16.1 for Windows (Stata Statistical Software; StataCorp LP, College Station, TX, United States). The alpha level was set at 0.05 for all tests. Where appropriate, we adjusted the p-values for multiple comparisons using Tukey's honestly significant difference (Tukey-Kramer adjustment with unequal sample sizes).

To address the first goal, we regressed scores of anxious feelings, catastrophic thinking and bodily complaints on age, gender, instrument group, and the four indices of musical experience and practice. Age was treated as continuous variable (in year) and gender as categorical variable with female as reference. Instrument was a categorical variable with the five categories singers (reference), wind players, string players, pianists, and percussionists. We treated the four variables about musical experience and practice as continuous variables. In a first step, we performed simple regressions testing the effect of each predictor separately. In a second step, we performed stepwise regression with forward selection with the goal of determining the best fitting model. We used the p-values from the simple regressions as criterion to determine which predictor goes in when (starting with the variable with the lowest p-value). We used the adjusted R^2 as criterion to keep or drop a variable. The adjusted R^2 increases only if the new term improves the model more than would be expected by chance. It decreases when a predictor improves the model by less than expected by chance. The final model is the one with the highest adjusted R^2 and can

include predictors with $p > 0.05$. We computed variance inflation factor (VIF) to evaluate multicollinearity. To test the hypothesis that singers would report lower levels of anxious feelings, catastrophizing, and bodily complaints than the other instrument groups, we contrasted singers vs. the other four groups together.

To address the second goal, we used a similar procedure. We regressed self-rated change in performance quality from practice to public performance (with higher scores corresponding to a worsening of the performance) on the variables anxious feelings, catastrophic thinking, all bodily complaints, breathing-related complaints, mouth- and throat-related complaints, and hand- and arm-related complaints, first one by one and then stepwise with forward selection.

TABLE 1 | Descriptive statistics for anxious feelings, catastrophic thinking, bodily complaints, and self-rated change in performance quality from practice to public performance.

	M	*SD*	Min	Max	*n*
Anxious feelings	46.8	10.9	25	75	179
Catastrophic thinking	3.1	2.4	0	12	179
All bodily complaints	0.8	0.5	0	2.6	174
Breathing-related complaints	1.1	0.9	0	3.4	174
Mouth- and throat-related complaints	0.7	0.8	0	4	177
Hand- and arm-related complaints	1.2	0.8	0	4	177
Number of severe complaints	4.1	4.1	0	20	174
	N	**%**			
Self-rated change in performance quality from practice to public performance					
Better	13	7			
Rather better	38	21			
Neither better nor worse	32	18			
Rather worse	61	33			
Worse	16	9			
I do not know	22	12			

RESULTS

Descriptive statistics are given in **Table 1** and **Supplementary Tables 1–5**. **Figure 1** shows the estimated marginal means of the MPA components for the five instrument groups. Across all tested regression models, VIFs ranged from 1 to 2.61, suggesting no multicollinearity issues (Pallant, 2010).

Effects of Age, Gender, Instrument Group, Musical Experience, and Practice

Anxious Feelings

The simple regressions revealed significant effects of age, gender, and number of solo performances (**Table 2**). Age was positively associated with anxious feelings. Male students reported less anxious feelings than female students. A higher number of solo performances were associated with less anxious feelings. In the multiple regression analysis, we found that the best fitting model was one including age, gender, instrument group, years of instrument study, and number of solo performances, explaining 15.0% of variance in anxious feelings. The effects of age, gender, instrument group, and years of instrument study were statistically significant, whereas the effect of number of solo performances approached significance. As in the simple regression analyses, age was positively associated with anxious feelings, and male students reported less anxious feelings than female students. Singers and pianists exhibited the lowest and highest level of anxious feelings, respectively; the difference between these two groups was significant after adjustment for multiple testing. The contrast singers vs. the other four groups was significant [$F_{(1,167)} = 8.37$, $p = 0.004$, mean difference = 8.40, $SE = 2.90$]. More years of instrument study was significantly associated with lower levels of anxious feelings. A higher number of solo performances tended to be associated with less anxious feelings.

Catastrophizing

In the simple regressions, we obtained significant effects of gender and instrument group (**Table 3**). These two variables also formed the best fitting model in the multiple regression analysis, explaining 9.4% of variance in catastrophizing. Male students reported significantly less catastrophizing than female students. Singers and pianists reported the lowest and highest levels of catastrophizing, respectively; the difference between these two groups was significant after adjustment for multiple testing. The contrast singers vs. the other four groups was significant [$F_{(1,173)} = 6.13$, $p = 0.014$, mean difference = 1.35, $SE = 0.54$].

All Bodily Complaints

The simple regressions revealed significant effects of age and gender (**Table 4**). Age was positively associated with bodily complaints. Male students reported fewer bodily complaints than female students. In the multiple regression analysis, we found that the best fitting model was one including all seven predictors, explaining 12.6% of variance in bodily complaints. The effect of age was statistically significant, and the effects of gender and number of solo performances approached significance. Increasing age was associated with more bodily complaints. Male students tended to report fewer bodily complaints than female students. A higher number of solo performances tended to be associated with fewer bodily complaints. The contrast singers vs. the other four groups was not significant [$F_{(1,154)} = 0.10$, $p = 0.75$, mean difference = 0.05, $SE = 0.15$].

Breathing-Related Complaints

In the simple regression analysis, the effect of instrument group was significant, and the effect of age approached significance (**Table 5**). In the multiple regression analysis, we found that the best fitting model included age, instrument group, academic year, and number of solo performances. The effects of age and instrument group were significant, and the effect of number of solo performances approached significance. There was a positive association between age and breathing-related complaints. The

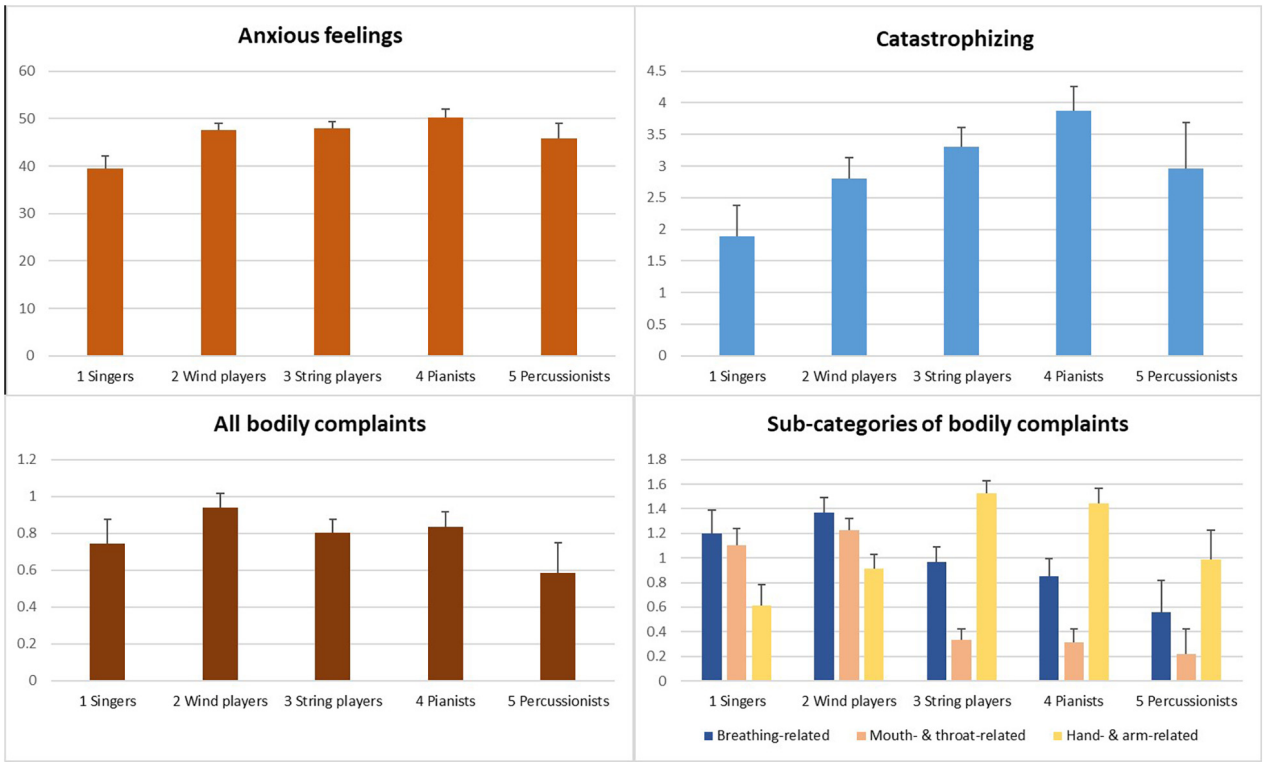

FIGURE 1 | Model-predicted marginal means (*SE*s) of anxious feelings, catastrophizing, all bodily complaints, and sub-categories of bodily complaints for the five instrument groups (see **Supplementary Tables 6–8** for all pairwise comparisons).

TABLE 2 | Results of the linear regression analyses for anxious feelings.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.38	0.19	0.15	**0.048**	0.02	179	0.74	0.21	0.29	**<0.001**	0.15	0.11	176
Gender (reference = female)	−3.68	1.64	−0.17	**0.026**	0.03	179	−3.42	1.68	−0.16	**0.044**			
Instrument (reference = singers)				0.16	0.04	179				**0.025**			
Wind players	4.09	2.71	0.17				7.40	2.91	0.34				
String players	5.06	2.67	0.22				7.86	3.12	0.37				
Pianists	6.94	2.85	0.26				10.54	3.24	0.41				
Percussionists	2.07	3.96	0.05				4.81	4.29	0.14				
Academic year	−0.22	0.50	−0.03	0.65	0.00	174							
Years of instrument study	0.06	0.17	0.03	0.72	0.00	179	−0.44	0.21	−0.19	**0.038**			
Hours of daily practice	0.37	0.45	0.06	0.42	0.00	177							
Number of solo performances	−1.14	0.48	−0.18	**0.018**	0.03	176	−0.84	0.49	−0.13	0.089			

Statistically significant effects are in bold.

contrast singers and wind players vs. string players, pianists, and percussionists was significant [$F_{(1,158)}$ = 9.39, p = 0.003, mean difference = 0.49, SE = 0.16]. A higher number of solo performances tended to be associated with fewer breathing-related complaints.

Mouth- and Throat-Related Complaints

In the simple regression analysis, we obtained significant effects of instrument group, years of instrument study, and hours of daily practice (**Table 6**). More years of instrument study and more hours of daily practice were associated with fewer mouth- and throat-related complaints. In the multiple regression analysis, we found that the best fitting model included only instrument group. This model explained 30.1% of the variance in mouth- and throat-related complaints. The contrast singers and wind players vs. string players, pianists, and percussionists was significant [$F_{(1,172)}$ = 55.97, p < 0.001, mean difference = 0.88, SE = 0.12].

TABLE 3 | Results of the linear regression analyses for catastrophic thinking.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.01	0.04	0.03	0.72	0.00	179					0.09	0.07	179
Gender (reference = female)	−0.87	0.36	−0.18	**0.017**	0.03	179	−0.83	0.38	−0.17	**0.028**			
Instrument (reference = singers)				**0.015**	0.07	179				**0.022**			
Wind players	0.64	0.59	0.12				0.92	0.60	0.17				
String players	1.32	0.58	0.26				1.42	0.57	0.28				
Pianists	1.93	0.62	0.33				2.00	0.62	0.34				
Percussionists	0.50	0.86	0.05				1.08	0.23	0.11				
Academic year	0.02	0.11	0.01	0.85	0.00	174							
Years of instrument study	0.02	0.04	0.04	0.56	0.00	179							
Hours of daily practice	0.13	0.10	0.10	0.18	0.01	177							
Number of solo performances	−0.10	0.11	−0.07	0.37	0.00	176							

Statistically significant effects are in bold.

TABLE 4 | Results of the linear regression analyses for all bodily complaints.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.02	0.01	0.17	**0.022**	0.03	174	0.03	0.01	0.29	**0.003**	0.13	0.07	165
Gender (reference = female)	−0.16	0.07	−0.16	**0.040**	0.02	174	−0.16	0.08	−0.16	0.054			
Instrument (reference = singers)				0.37	0.02	174				0.28			
Wind players	0.07	0.13	0.07				0.20	0.15	0.18				
String players	−0.05	0.12	−0.05				0.06	0.16	0.06				
Pianists	−0.04	0.13	−0.03				0.09	0.17	0.07				
Percussionists	−0.25	0.19	−0.12				−0.16	0.22	−0.08				
Academic year	−0.01	0.02	−0.04	0.60	0.00	169	−0.01	0.03	−0.05	0.56			
Years of instrument study	−0.00	0.01	−0.04	0.61	0.00	174	−0.02	0.01	−0.16	0.14			
Hours of daily practice	0.00	0.02	0.01	0.89	0.00	173	0.03	0.02	0.11	0.18			
Number of solo performances	−0.04	0.02	−0.12	0.11	0.02	171	−0.04	0.02	−0.15	0.060			

Statistically significant effects are in bold.

TABLE 5 | Results of the linear regression analyses for breathing-related complaints.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.03	0.02	0.13	0.098	0.02	174	0.04	0.02	0.17	**0.039**	0.12	0.08	166
Gender (reference = female)	−0.14	0.14	−0.08	0.30	0.01	174							
Instrument (reference = singers)				**0.006**	0.08	174				**0.016**			
Wind players	0.23	0.22	0.12				0.17	0.23	0.08				
String players	−0.22	0.22	−0.12				−0.23	0.23	−0.12				
Pianists	−0.36	0.23	−0.17				−0.35	0.24	−0.16				
Percussionists	−0.58	0.32	−0.16				−0.64	0.32	−0.18				
Academic year	−0.04	0.04	−0.08	0.31	0.01	169	−0.04	0.04	−0.08	0.32			
Years of instrument study	−0.01	0.01	−0.07	0.34	0.01	174							
Hours of daily practice	−0.02	0.04	−0.03	0.67	0.00	173							
Number of solo performances	−0.05	0.04	−0.09	0.23	0.01	171	−0.07	0.04	−0.14	0.076			

Statistically significant effects are in bold.

Hand- and Arm-Related Complaints

In the simple regression analysis, we obtained significant effects of gender, instrument group, hours of daily practice, and number of solo performances (**Table 7**). Male students reported fewer hand- and arm-related complaints than female students. More hours of daily practice were associated with more hand- and arm-related complaints, and a higher number of solo performances were associated with fewer hand- and arm-related complaints.

TABLE 6 | Results of the linear regression analyses for mouth- and throat-related complaints.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.02	0.01	0.09	0.21	0.01	177					0.30	0.29	177
Gender (reference = female)	0.04	0.12	0.03	0.71	0.00	177							
Instrument (reference = singers)				**<0.001**	0.30	177				**<0.001**			
Wind players	0.12	0.17	0.07				0.12	0.17	0.07				
String players	−0.77	0.16	−0.46				−0.77	0.16	−0.46				
Pianists	−0.79	0.18	−0.41				−0.79	0.18	−0.41				
Percussionists	−0.88	0.24	−0.27				−0.88	0.24	−0.27				
Academic year	−0.06	0.04	−0.12	0.11	0.02	172							
Years of instrument study	−0.03	0.01	−0.19	**0.010**	0.04	177							
Hours of daily practice	−0.08	0.03	−0.19	**0.010**	0.04	176							
Number of solo performances	0.04	0.04	0.09	0.22	0.01	174							

Statistically significant effects are in bold.

TABLE 7 | Results of the linear regression analyses for hand- and arm-related complaints.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Age	0.00	0.01	0.01	0.86	0.00	177	0.02	0.01	0.08	0.25	0.26	0.23	173
Gender (reference = female)	−0.35	0.13	−0.21	**0.005**	0.04	177	−0.28	0.12	−0.16	**0.027**			
Instrument (reference = singers)				**<0.001**	0.21	177				**<0.001**			
Wind players	0.30	0.19	0.16				0.30	0.20	0.16				
String players	0.99	0.19	0.56				0.91	0.20	0.51				
Pianists	0.90	0.20	0.44				0.83	0.21	0.40				
Percussionists	0.36	0.28	0.11				0.37	0.31	0.11				
Academic year	−0.00	0.04	−0.00	0.96	0.00	172							
Years of instrument study	0.02	0.01	0.12	0.12	0.01	177							
Hours of daily practice	0.07	0.03	0.16	**0.034**	0.03	176	0.04	0.03	0.08	0.27			
Number of solo performances	−0.10	0.04	−0.20	**0.010**	0.03	174	−0.06	0.04	−0.13	0.079			

Statistically significant effects are in bold.

In the multiple regression analysis, we found that the best fitting model included age, gender, instrument group, hours of daily practice, and number of solo performances. The effects of gender and instrument group were significant, and the effect of number of solo performances approached significance. The contrast string players and pianists vs. singers, wind players and percussionists was significant [$F_{(1,164)} = 23.91$, $p < 0.001$, mean difference = 0.65, $SE = 0.13$].

Music Performance Anxiety Components as Predictors of Self-Rated Change in Performance Quality From Practice to Public Performance

Twenty-two participants answered the question about the change in performance quality from practice to public performance with "I do not know" and were thus not included in the analyses of this variable. The simple regressions revealed that all predictors except mouth- and throat-related complaints were significantly associated with self-rated worsening of performance quality from practice to public performance (**Table 8**). In the multiple regression analysis, we found that the best fitting model was one including anxious feelings and breathing-related complaints, explaining 12.1% of variance in the outcome variable.

DISCUSSION

Predictors of Music Performance Anxiety Components

Age

We found that age was positively associated with anxious feelings, all bodily complaints and breathing-related complaints. The age range of our sample was 15–45 years. Our findings are concordant with results by Zarza-Alzugaray et al. (2018) who reported a significant positive association between age and MPA in university music students aged 16–51 years. They are also in agreement with the literature on anxiety disorders according to which the prevalence of anxiety disorders increases until middle age and then decreases in late adulthood (Bandelow and Michaelis, 2015). All the studies that found a significant negative

TABLE 8 | Results of the linear regression analyses for MPA components as predictors of self-rated change in performance quality from practice to public performance.

	Simple regression						Multiple regression						
Predictors	***B***	***SE***	**β**	***p***	R^2	***n***	***B***	***SE***	**β**	***p***	R^2	$R^2_{adj.}$	***n***
Anxious feelings	0.03	0.01	0.28	**0.001**	0.08	154	0.02	0.01	0.20	**0.017**	0.12	0.11	150
Catastrophizing	0.09	0.04	0.19	**0.021**	0.03	154							
Bodily complaints													
All	0.57	0.18	0.24	**0.002**	0.06	151							
Breathing-related	0.38	0.10	0.29	**<0.001**	0.08	151	0.30	0.11	0.23	**0.005**			
Mouth- and throat-related	0.19	0.12	0.13	0.10	0.02	154							
Hand- and arm-related	0.22	0.11	0.16	**0.049**	0.03	153							

Statistically significant effects are in bold.

association between age and MPA investigated a population that included musicians in their sixties and seventies, and the samples consisted of professional musicians only (Kenny et al., 2014) or both music students and professionals (Huston, 2001; Osborne and Franklin, 2002; Butkovic et al., 2021). Establishing the link between age and MPA can be difficult because age often covaries with musicians' professional status. Students and amateur musicians generally suffer from higher MPA than professionals (Steptoe and Fidler, 1987; Kobori et al., 2011; Biasutti and Concina, 2014). Kobori et al. (2011) found that professional status and not age was a significant predictor of MPA. A tendency to less MPA might be seen with an age older than about 45–50 years (Fernholz et al., 2019). Whether this reflects a genuine decrease in MPA after middle age or a cohort effect is unknown. It is possible that only the most resilient musicians stay in the business beyond a certain age whereas those who are more severely affected by MPA leave prematurely.

Gender

Female participants reported significantly more anxious feelings, catastrophic thinking, and hand- and arm-related complaints than male participants. We observed a similar trend for all bodily complaints. As mentioned in the introduction, many researchers have observed higher levels of MPA among female musicians than male musicians (e.g., Hildebrandt et al., 2012; Lupiáñez et al., 2021). The present study extends previous work by showing that gender affects all three assessed facets of MPA to a similar degree in a sample of classical music students. The often observed gender effect on MPA is in agreement with the broader literature showing greater vulnerability of females than males for anxiety, worry, and stress (Robichaud et al., 2003; Matud, 2004; Bandelow and Michaelis, 2015). This has been attributed to a combination of gender differences in psychosocial contributors (e.g., childhood sexual abuse, chronic stressors), self-concept, coping styles, genetic, and neurobiological factors (Bangasser et al., 2010; Nolen-Hoeksema, 2012; Bandelow and Domschke, 2015). Among the studies that did not find significant gender differences in MPA (e.g., Fehm and Schmidt, 2006; Khalsa et al., 2009; Kobori et al., 2011; Allen, 2013; Barbar et al., 2014; Cohen and Bodner, 2021), several of them did show a trend in the expected direction. The lack of statistical significance could be due to insufficient statistical power (e.g., Fehm and Schmidt, 2006). On average, the studies that failed to find a significant gender effect on MPA had smaller samples than the studies that found a significant gender effect.

Instrument Group

Singers reported significantly lower levels of anxious feelings and catastrophizing than instrumentalists, in particular pianists. This finding is in line and extends the results of several studies acknowledged in the introduction (e.g., Robson and Kenny, 2017). We offer two possible explanations for these results. First, the level of perceived exposure to the audience and thus to negative social evaluation might be lower among singers than instrumentalists. When performing solo, singers are accompanied by a pianist, whereas pianists are on their own and thus the sole object of social evaluation; the other instrumentalists have solo repertoire both with and without accompaniment. Compared to choral ensembles, the number of musicians playing a given instrument or part within instrumental ensembles are generally smaller. Social support provided by non-evaluative others buffers stress responses to performance situations (e.g., Heinrichs et al., 2003). A second possibility is the reliance on an internal instrument for singers as opposed to one that is external for instrumentalists. Ryan and Andrews (2009) argue that singers might feel a greater sense of control over their instrument and thus experience less anxiety than instrumentalists.

Instrument group did not play a significant role in explaining average scores of all bodily complaints but was a major predictor of all three sub-categories of bodily complaints. Singers and wind players reported significantly more severe breathing-related and mouth- and throat-related complaints than the other three groups. String players and pianists reported significantly more severe hand- and arm-related complaints than the other three groups. These results are consistent with an interpretation that the level of bodily discomfort depends on the relevance that specific body parts have for the act of playing the specific instrument. Breathing and the mouth/throat region are particularly important for singing and playing a wind instrument. Superior fine motor skills in the hand/arm region are most important for playing a string instrument or the piano. We speculate that these differences may reflect differences in musicians' focus of attention.

The finding that the severity of specific bodily complaints strongly depends on the instrument group has the potential to influence the development and use of assessment tools

for MPA. Popular questionnaires such as the Performance Anxiety Inventory (Nagel et al., 1981), the Performance Anxiety Questionnaire (Cox and Kenardy, 1993), the Competitive State Anxiety Inventory (Cox et al., 2003), and the Kenny Music Performance Anxiety Inventory (Kenny et al., 2014) include four to seven somatic symptoms. Whereas the symptom "palpitations" appears in all four questionnaires and the symptoms "muscle tension" and "sweaty hands" appear in three of them, breathing-related symptoms are not included in any of them. Important questions to address in future research are whether it would be useful to develop MPA questionnaires specific to each instrument group or an MPA questionnaire that better incorporates items related to the bodily complaints that are most relevant to the different instrument groups.

Knowledge about the associations between instrument group and bodily complaints could also be useful to teachers and therapists in helping students with performance preparation (Hildebrandt, 2009). As an example, one promising approach to improve people's stress response to demanding tasks is stress arousal reappraisal, which consists in reinterpreting physiological arousal as adaptive and beneficial for task performance (Jamieson et al., 2018). This method could be tailored to the needs of the different instrument groups. For instance, stress arousal reappraisal for singers may be most effective if it mainly focuses on reinterpreting breathing-, mouth-, and throat-related symptoms.

Musical Experience and Practice

As hypothesized, participants' academic year was not a significant predictor of any MPA components. Participants' number of years of instrument study showed a significant negative relationship with anxious feelings in the multiple regression and with mouth- and throat-related complaints in the simple regression. These findings are in agreement with reports by Huston (2001), Osborne and Franklin (2002), and Ryan and Andrews (2009) and with the idea that length of music training could have a positive impact on MPA. With increasing years of musical experience, musicians may acquire more confidence or develop effective coping strategies to deal with performance stress (Huston, 2001). Nevertheless, we caution against overinterpreting the two significant effects of years of instrument study because the effect on anxious feelings was far from significant in the simple regression, and the effect on mouth- and throat-related complaints was absent in the multiple regression. Moreover, no other significant effects emerged. As reviewed in the introduction, most studies have found no significant association between years of instrument study and MPA (e.g., Casanova et al., 2018).

More hours of daily practice were associated with fewer mouth- and throat-related complaints and more hand- and arm-related complaints, but these effects were not significant in the multiple regressions making us questioning their interpretability. Hours of daily practice had no other significant effects. Overall, our findings are largely in line with reports by Kobori et al. (2011); Kenny et al. (2013), Sârbescu and Dorgo (2014), and Tan et al. (2021) but contrast with studies that reported a significant negative association between amount of practice and MPA (Biasutti and Concina, 2014; González et al., 2018; Dobos et al., 2019). Methodological differences could partly explain these discrepancies. First, there are differences in how authors defined musical practice. Our assessment included individual practice, rehearsal and courses; in contrast, Biasutti and Concina (2014) considered individual practice only. In this regard, Kenny et al. (2013) found a significant negative correlation between MPA and the number of practice sessions per week but not between MPA and the number of hours of weekly practice. Second, the analyses performed in the three studies reporting a significant effect of amount of practice did not include other relevant predictors such as instrument group. In our study, instrument groups significantly differ from each other in their amount of daily practice. Increasing individual practice time is one of the most common strategies that musicians report to use to cope with MPA (Kenny et al., 2014; Burin and Osorio, 2017). Whether practicing long hours reduces MPA is unclear. Practice serves the goal of achieving mastery, which should affect positively MPA as theorized by Wilson (2002). It is possible that beyond a certain number of hours of practice, there is no additional benefit in terms of mastery and MPA. Moreover, an obvious limitation of this measure is that it considers the amount of time practiced but not the quality and type of practice (e.g., Williamon and Valentine, 2000). The degree to which practice is deliberate and reflective might be particularly important (Davis, 2017).

Participants' number of solo performances tended to be negatively related to anxious feelings, all bodily complaints and two sub-categories of complaints in the multiple regressions. Two of these relationships were statistically significant in the simple regressions. These findings are in line and extend reports by several authors who found that higher number of (solo) public performances are associated with lower levels of MPA (e.g., Casanova et al., 2018; González et al., 2018; Zarza-Alzugaray et al., 2020). The underlying mechanisms of this relationship cannot be inferred from this body of work. Performance experience may allow musicians to improve their ways of managing performance situations and thus, over time, reduce their MPA. Repeated exposure to the object or situation that causes anxiety is part of cognitive-behavioral therapy for anxiety disorders (Bissonnette et al., 2015; Kaczkurkin and Foa, 2015). On the other side, high levels of MPA can lead musicians to avoiding performance situations (e.g., Studer et al., 2011b). Finally, compared to musicians with low levels of MPA, musicians with high levels of MPA may get fewer performance opportunities because of poorer performance.

Self-Rated Change in Performance Quality From Practice to Public Performance

Of the 160 participants who rated their habitual performance quality, 48% reported that they generally perform rather worse or worse than in practice, whereas 32% reported that they generally perform rather better or better. We are not aware of other survey studies assessing self-rated change in performance quality from practice to public performance. In

an experimental study, Studer et al. (2014) found that 44% of music students rated their public performance as being better than their practice performance, whereas 28% rated their practice performance as being better. It is difficult to compare Studer et al.'s (2014) findings with the present findings because in that study all participants performed in the order practice performance-public performance 1 week apart. To what extent the perceived changes in performance quality from practice to public performance corresponds to "objective" changes in performance quality is unknown. In a sample of 101 violin students, 20% performed significantly worse during an examination than during lessons as rated by their violin teachers, but performance changes as rated by the violinists were not assessed (Kivimäki, 1995). Findings have been equivocal regarding the effects of the performance situation (practice vs. public) on expert-rated performance quality (Hamann and Sobaje, 1983; Craske and Craig, 1984; Yoshie et al., 2009a). Correlations between self-ratings and expert ratings are weak to moderate (Kenny et al., 2013; Tief and Gröpel, 2021). The belief that one's performance is generally worse when performing in public than in practice can contribute to the development and maintenance of a negative self-concept as musician ("I am a poor performer"), with potential adverse career and health consequences. It is important to identify those students who have an unrealistically negative perception of their level of public performance and address their misperception. Studies assessing both self-rated and expert-rated performance quality during practice and public performances are needed (Guyon et al., 2020b).

The predicted positive relationships between MPA components and self-rated worsening of performance quality from practice to public performance were statistically significant for all components except mouth- and throat-related complaints. Breathing-related complaints and anxious feelings together were the best predictors in the multiple regression, explaining 12.1% of the variance. Breathing-related complaints are partly associated with actual changes in breathing patterns. Specifically, shortness of breath and difficulty in breathing deeply enough are positively associated with more sighing and deeper, slower, and more irregular breathing in music students before performing (Guyon et al., 2020a). Breathing (dis)regulation has been associated with cognitive and motor performance (e.g., Karavidas et al., 2010; Grassmann et al., 2016). Respiration is situated at the intersection of automatic functioning and voluntary control and is an important focus of attention of musicians when playing under pressure (Buma et al., 2015; Oudejans et al., 2017). Breathing is a possible target for interventions (van Dixhoorn, 2007; Wells et al., 2012). Based on the findings of the present study and on these considerations, we think that more research is warranted to refine our understanding about the link between breathing-related complaints, breathing patterns, and music performance quality.

Limitations

The cross-sectional nature of this survey does not allow for any definitive conclusions about causal relationships between variables. Longitudinal studies (e.g., Hildebrandt et al., 2012) and ambulatory assessment studies (e.g., Gomez et al., 2018) measuring musicians' experiences during practice and different performance situations across time are needed. The focus of the present study was on the "negative side" of performing. It would be important to also consider the "positive side" (e.g., flow, performance boost; Simoens et al., 2015; Cohen and Bodner, 2021). Moreover, we only considered a limited number of potential predictors of the MPA dimensions. Future studies should extend the present work and consider other factors such as personality traits (e.g., Sadler and Miller, 2010). The number of participants in the different instrument groups ranged from 11 to 59. Large differences in sample size between instrument groups is a common problem in research because some instruments are more "popular" than others. Studies have considered woodwind players and brass players separately (e.g., Cohen and Bodner, 2021). Preliminary analyses showed that these two groups behaved very similarly in the present study; we, thus, deemed appropriate to merge them into one. The instrument used to assess self-rated change in performance quality from practice to public performance could be refined by including items that assess different performance criteria and distinguish between factors such as repertoire and performance situations.

CONCLUSION

In conclusion, we found that age, gender, and instrument group were the main predictors of MPA components. Older age was associated with more anxious feelings and more bodily complaints; being female and an instrumentalist was associated with more anxious feelings and catastrophizing than being male and a singer. The degree of discomfort associated with breathing-related, mouth- and throat-related, and hand- and arm-related complaints varied significantly across instrument groups. These findings highlight the need to examine musicians according to their age, gender, and instrument group rather than as one homogenous population. Overall, our indices of musical experience and practice played a secondary role in predicting MPA components.

Almost half of the participants reported that the quality of their public performances is generally worse than the quality of their practice performances. Much work is needed to help music students better cope with the "pressure" of performing and ultimately be able to perform at their best and thrive as performing artists. Anxious feelings and breathing-related complaints emerged as the best MPA facets of all to predict self-rated worsening of performance quality from practice to public performance. This finding highlights the potential usefulness of considering breathing-related complaints (which are not part of any of the questionnaires commonly used to assess MPA) in the study of MPA and music performance.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Canton of Vaud, Switzerland. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it fo publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.905680/full#supplementary-material

REFERENCES

Allen, R. (2013). Free improvisation and performance anxiety among piano students. *Psychol. Music* 41, 75–88. doi: 10.1177/0305735611415750

Aufegger, L., and Wasley, D. (2020). Virtual reality feedback influences musicians' physical responses and mental attitude towards performing. *Music Med.* 12, 157–166. doi: 10.47513/mmd.v12i3.732

Bandelow, B., and Domschke, K. (2015). "Panic disorder," in *Anxiety Disorder Gender*, 2 Edn, eds D. J. Stein and B. Vythilingum (Cham: Springer Int Publishing), 31–48.

Bandelow, B., and Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues Clin. Neurosci.* 17, 327–335. doi: 10.31887/DCNS.2015.17.3/bbandelow

Bangasser, D. A., Curtis, A., Reyes, B. A., Bethea, T. T., Parastatidis, I., Ischiropoulos, H., et al. (2010). Sex differences in corticotropin-releasing factor receptor signaling and trafficking: potential role in female vulnerability to stress-related psychopathology. *Mol. Psychiatry* 15, 896–904. doi: 10.1038/mp.2010.66

Barbar, A. E., de Souza Crippa, J. A., and de Lima Osorio, F. (2014). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 152–154, 381–386. doi: 10.1016/j.jad.2013.09.041

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Musicae Sci.* 18, 189–202. doi: 10.1177/1029864914523282

Bissonnette, J., Dube, F., Provencher, M. D., and Sala, M. T. M. (2015). Virtual reality exposure training for musicians: its effect on performance anxiety and quality. *Med. Probl. Perform. Art.* 30, 169–177. doi: 10.21091/mppa.2015.3032

Boucher, H., and Ryan, C. A. (2011). Performance stress and the very young musician. *J. Res. Music Educ.* 58, 329–345. doi: 10.1177/0022429410386965

Buma, L. A., Bakker, F. C., and Oudejans, R. R. D. (2015). Exploring the thoughts and focus of attention of elite musicians under pressure. *Psychol. Music* 43, 459–472. doi: 10.1177/0305735613517285

Burin, A. B., and Osorio, F. L. (2017). Music performance anxiety: a critical review of etiological aspects, perceived causes, coping strategies and treatment. *Arch. Clin. Psychiatry* 44, 127–133. doi: 10.1590/0101-60830000000136

Butkovic, A., Vukojevic, N., and Carevic, S. (2021). Music performance anxiety and perfectionism in Croatian musicians. *Psychol. Music* 50, 100–110. doi: 10.1177/0305735620978692

Casanova, O., Zarza, F. J., and Orejudo, S. (2018). Differences in performance anxiety levels among advanced conservatory students in Spain, according to type of instrument and academic year of enrolment. *Music Educ. Res.* 20, 377–389. doi: 10.1080/14613808.2018.1433145

Chan, M.-Y. (2011). *The Relationship Between Music Performance Anxiety, Age, Self-Esteem, and Performance Outcomes in Hong Kong Music Students.* Doctoral thesis. Durham: Durham University.

Clark, D. B., and Agras, W. S. (1991). The assessment and treatment of performance anxiety in musicians. *Am. J. Psychiatry* 148, 598–605. doi: 10.1176/ajp.148.5.598

Cohen, S., and Bodner, E. (2021). Flow and music performance anxiety: the influence of contextual and background variables. *Musicae Sci.* 25, 25–44. doi: 10.1177/1029864919838600

Cornett, V., and Urhan, G. (2021). Performance anxiety experiences and coping techniques of Turkish music students and their teachers. *Int. J. Music Educ.* 39, 504–519. doi: 10.1177/02557614211005907

Coskun-Sentürk, G., and Cirakoglu, O. C. (2018). How guilt/shame proneness and coping styles are related to music performance anxiety and stress symptoms by gender. *Psychol. Music* 46, 682–698. doi: 10.1177/0305735617721338

Cox, R. H., Martens, M. P., and Russell, W. D. (2003). Measuring anxiety in athletics: the revised competitive state anxiety inventory–2. *J. Sport Exerc. Psychol.* 25, 519–533. doi: 10.1123/jsep.25.4.519

Cox, W. J., and Kenardy, J. (1993). Performance anxiety, social phobia, and setting effects in instrumental music students. *J. Anxiety Disord.* 7, 49–60. doi: 10.1016/0887-6185(93)90020-L

Craske, M. G., and Craig, K. D. (1984). Musical performance anxiety: the three-systems model and self-efficacy theory. *Behav. Res. Ther.* 22, 267–280. doi: 10.1016/0005-7967(84)90007-X

Davis, V. W. (2017). Error reflection: embracing growth mindset in the general music classroom. *Gen. Music Today* 30, 11–17. doi: 10.1177/1048371316667160

Dempsey, E., and Comeau, G. (2019). Music performance anxiety and self-efficacy in young musicians: effects of gender and age. *Music Perform. Res.* 9, 60–79.

Dobos, B., Piko, B. F., and Kenny, D. T. (2019). Music performance anxiety and its relationship with social phobia and dimensions of perfectionism. *Res. Stud. Music Educ.* 41, 310–326. doi: 10.1177/1321103x18804295

Ericsson, K. A., Krampe, R. T., and Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychol. Rev.* 100, 363–406. doi: 10.1037/0033-295X.100.3.363

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disord.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/S0033291719001910

Fishbein, M., and Middlestadt, S. E. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Probl. Perform. Art.* 3, 1–8.

Gomez, P., Nielsen, C., Studer, R. K., Hildebrandt, H., Klumb, P. L., Nater, U. M., et al. (2018). Prolonged performance-related neuroendocrine activation and perseverative cognition in low- and high-anxious university music students. *Psychoneuroendocrinology* 95, 18–27. doi: 10.1016/j.psyneuen.2018.05.018

González, A., Blanco-Piñeiro, P., and Díaz-Pereira, M. P. (2018). Music performance anxiety: exploring structural relations with self-efficacy, boost, and self-rated performance. *Psychol. Music* 46, 831–847. doi: 10.1177/0305735617727822

Grassmann, M., Vlemincx, E., von Leupoldt, A., and Van den Bergh, O. (2016). The role of respiratory measures to assess mental load in pilot selection. *Ergonomics* 59, 745–753. doi: 10.1080/00140139.2015.1090019

Guyon, A. J. A. A., Studer, R. K., Hildebrandt, H., Horsch, A., Nater, U. M., and Gomez, P. (2020b). Music performance anxiety from the challenge and threat

perspective: psychophysiological and performance outcomes. *BMC Psychol.* 8:87. doi: 10.1186/s40359-020-00448-8

Guyon, A. J. A. A., Cannavò, R., Studer, R. K., Hildebrandt, H., Danuser, B., Vlemincx, E., et al. (2020a). Respiratory variability, sighing, anxiety, and breathing symptoms in low- and high-anxious music students before and after performing. *Front. Psychol.* 11:303. doi: 10.3389/fpsyg.2020.00303

Hamann, D. L., and Sobaje, M. (1983). Anxiety and the college musician: a study of performance conditions and subject variables. *Psychol. Music* 11, 37–50. doi: 10.1177/0305735683111005

Heinrichs, M., Baumgartner, T., Kirschbaum, C., and Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Biol. Psychiatry* 54, 1389–1398. doi: 10.1016/S0006-3223(03)00465-7

Hildebrandt, H. (2009). "Teaching music physiology and motor learning processes at a university: experience and evaluation," in *Art in Motion. Musical and Athletic Motor Learning and Performance*, ed. A. Mornell (Frankfurt: Peter Lang), 191–222.

Hildebrandt, H., Nübling, M., and Candia, V. (2012). Increment of fatigue, depression, and stage fright during the first year of high-level education in music students. *Med. Probl. Perform. Art.* 27, 43–48. doi: 10.21091/mppa.2012.1008

Huston, J. L. (2001). Familial antecedents of musical performance anxiety: a comparison with social anxiety. *Dissertation Abstr. Int. Section B Sci. Eng.* 62:551.

Iusca, D., and Dafinoiu, I. (2012). Performance anxiety and musical level of undergraduate students in exam situations: the role of gender and musical instrument. *Procedia Soc. Behav. Sci.* 33, 448–452. doi: 10.1016/j.sbspro.2012.01.161

Jamieson, J. P., Hangen, E. J., Lee, H. Y., and Yeager, D. S. (2018). Capitalizing on appraisal processes to improve affective responses to social stress. *Emot. Rev.* 10, 30–39. doi: 10.1177/1754073917693085

Kaczkurkin, A. N., and Foa, E. B. (2015). Cognitive-behavioral therapy for anxiety disorders: an update on the empirical evidence. *Dialogues Clin. Neurosci.* 17, 337–346. doi: 10.31887/DCNS.2015.17.3/akaczkurkin

Karavidas, M. K., Lehrer, P. M., Lu, S. E., Vaschillo, E., Vaschillo, B., and Cheng, A. (2010). The effects of workload on respiratory variables in simulated flight: a preliminary study. *Biol. Psychol.* 84, 157–160. doi: 10.1016/j.biopsycho.2009.12.009

Kaspersen, M., and Gotestam, K. (2002). A survey of music performance anxiety among Norwegian music students. *Eur. J. Psychiatry* 16, 69–80.

Kenny, D. T. (2010). "The role of negative emotions in performance anxiety," in *Handbook of Music and Emotion: Theory, Research, Applications*, eds P. N. Juslin and J. Sloboda (Oxford: Oxford University Press), 425–451.

Kenny, D. T., Fortune, J. M., and Ackermann, B. (2013). Predictors of music performance anxiety during skilled performance in tertiary flute players. *Psychol. Music* 41, 306–328. doi: 10.1177/0305735611425904

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Khalsa, S. B., Shorter, S. M., Cope, S., Wyshak, G., and Sklar, E. (2009). Yoga ameliorates performance anxiety and mood disturbance in young professional musicians. *Appl. Psychophysiol. Biofeedback* 34, 279–289. doi: 10.1007/s10484-009-9103-4

Kivimäki, M. (1995). Test anxiety, below-capacity performance, and poor test performance: intrasubject approach with violin students. *Pers. Individ. Dif.* 18, 47–55. doi: 10.1016/0191-8869(94)00115-9

Kobori, O., Yoshie, M., Kudo, K., and Ohtsuki, T. (2011). Traits and cognitions of perfectionism and their relation with coping style, effort, achievement, and performance anxiety in Japanese musicians. *J. Anxiety Disord.* 25, 674–679. doi: 10.1016/j.janxdis.2011.03.001

Kokotsaki, D., and Davidson, J. W. (2003). Investigating musical performance anxiety among music college singing students: a quantitative analysis. *Music Educ. Res.* 5, 45–59. doi: 10.1080/14613800307103

Levy, J. J., Castille, C. M., and Farley, J. A. (2011). An investigation of musical performance anxiety in the marching arts. *Med. Probl. Perform. Art.* 26, 30–34. doi: 10.21091/mppa.2011.1004

Liston, M., Frost, A. A. M., and Mohr, P. B. (2003). The prediction of musical performance anxiety. *Med. Probl. Perform. Art.* 18, 120–125. doi: 10.21091/mppa.2003.3021

Lupiáñez, M., Ortiz, F. D., Vila, J., and Muñoz, M. A. (2021). Predictors of music performance anxiety in conservatory students. *Psychol. Music* doi: 10.1177/03057356211032290 [Epub ahead of print].

MacIntyre, P. D., Potter, G. K., and Burns, J. N. (2012). The socio-educational model of music motivation. *J. Res. Music Educ.* 60, 129–144. doi: 10.1177/0022429412444609

Matud, M. P. (2004). Gender differences in stress and coping styles. *Pers. Individ. Dif.* 37, 1401–1415. doi: 10.1016/j.paid.2004.01.010

Nagel, J. J., Himle, D., and Papsdorf, J. (1981). Coping with performance anxiety. *NATS Bull.* 37, 26–33.

Nicholson, D. R., Cody, M. W., and Beck, J. G. (2015). Anxiety in musicians: on and off stage. *Psychol. Music* 43, 438–449. doi: 10.1177/0305735614540018

Nielsen, C., Studer, R. K., Hildebrandt, H., Nater, U. M., Wild, P., Danuser, B., et al. (2018). The relationship between music performance anxiety, subjective performance quality and post-event rumination among music students. *Psychol. Music* 46, 136–152. doi: 10.1177/0305735617706539

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: the role of gender. *Annu. Rev. Clin. Psychol.* 8, 161–187. doi: 10.1146/annurev-clinpsy-032511-143109

Nusseck, M., Zander, M., and Spahn, C. (2015). Music performance anxiety in young musicians. *Med. Probl. Perform. Art.* 30, 30–37. doi: 10.21091/mppa.2015.1005

Orejudo, S., Zarza-Alzugaray, F. J., and Casanova, O. (2018). Music performance anxiety. Substance use and career abandonment in Spanish music students. *Int. J. Music Educ.* 36, 460–472. doi: 10.1177/0255761418763903

Osborne, M. S., and Franklin, J. (2002). Cognitive processes in music performance anxiety. *Austr. J. Psychol.* 54, 86–93. doi: 10.1080/00049530210001706543

Osborne, M. S., Kenny, D. T., and Holsomback, R. (2005). Assessment of music performance anxiety in late childhood: a validation study of the Music Performance Anxiety Inventory for Adolescents (MPAI-A). *Int. J. Stress Manag.* 12, 312–330. doi: 10.1037/1072-5245.12.4.312

Oudejans, R. R., Spitse, A., Kralt, E., and Bakker, F. C. (2017). Exploring the thoughts and attentional focus of music students under pressure. *Psychol. Music* 45, 216–230. doi: 10.1177/0305735616656790

Pallant, J. (2010). *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS*, 4th Edn. Sydney, NSW: Allen & Unwin.

Papageorgi, I., Creech, A., and Welch, G. (2013). Perceived performance anxiety in advanced musicians specializing in different musical genres. *Psychol. Music* 41, 18–41. doi: 10.1177/0305735611408995

Patston, T., and Osborne, M. S. (2016). The developmental features of music performance anxiety and perfectionism in school age music students. *Perform. Enhanc. Health* 4, 42–49. doi: 10.1016/j.peh.2015.09.003

Penney, E. S., and Abbott, M. J. (2014). Anticipatory and post-event rumination in social anxiety disorder: a Review of the theoretical and empirical literature. *Behav. Change* 31, 79–101. doi: 10.1017/bec.2014.3

Rae, G., and McCambridge, K. (2004). Correlates of performance anxiety in practical music exams. *Psychol. Music* 32, 432–439. doi: 10.1177/0305735604046100

Rapee, R. M., and Lim, L. (1992). Discrepancy between self- and observer ratings of performance in social phobics. *J. Abnorm. Psychol.* 101, 728–731. doi: 10.1037/0021-843X.101.4.728

Robichaud, M., Dugas, M. J., and Conway, M. (2003). Gender differences in worry and associated cognitive-behavioral variables. *J. Anxiety Disord.* 17, 501–516. doi: 10.1016/s0887-6185(02)00237-2

Robson, K. E., and Kenny, D. T. (2017). Music performance anxiety in ensemble rehearsals and concerts: a comparison of music and non-music major undergraduate musicians. *Psychol. Music* 45, 868–885. doi: 10.1177/0305735617693472

Ryan, C., and Andrews, N. (2009). An investigation into the choral singer's experience of music performance anxiety. *J. Res. Music Educ.* 57, 108–126. doi: 10.1177/0022429409336132

Sadler, M. E., and Miller, C. J. (2010). Performance anxiety: a longitudinal study of the roles of personality and experience in musicians. *Soc. Psychol. Pers. Sci.* 1, 280–287. doi: 10.1177/1948550610370492

Sârbescu, P., and Dorgo, M. (2014). Frightened by the stage or by the public? Exploring the multidimensionality of music performance anxiety. *Psychol. Music* 42, 568–579. doi: 10.1177/0305735613483669

Schröder, H., and Liebelt, D. (1999). Psychologische phänomen- und bedingungsanalysen zur podiumsangst von studierenden an musikhochschulen. *Musikphysiol. Musikermed.* 6, 1–5.

Shoup, D. (1995). Survey of performance-related problems among high-school and junior high-school musicians. *Med. Probl. Perform. Art.* 10, 100–105.

Simoens, V. L., Puttonen, S., and Tervaniemi, M. (2015). Are music performance anxiety and performance boost perceived as extremes of the same continuum? *Psychol. Music* 43, 171–187. doi: 10.1177/0305735613499200

Spahn, C., Krampe, F., and Nusseck, M. (2021). Classifying different types of music performance anxiety. *Front. Psychol.* 12:538535. doi: 10.3389/fpsyg.2021.538535

Spielberger, C. (1983). *Manual for the State-Trait Anxiety Inventory (form Y)*. Palo Alto, CA: Consulting Psychologists Press.

Steptoe, A. (2001). "Negative emotions in music making: the problem of performance anxiety," in *Music and Emotion: Theory and Research*, eds P. N. Juslin and J. A. Sloboda (New York, NY: Oxford University Press Inc), 291–307.

Steptoe, A., and Fidler, H. (1987). Stage fright in orchestral musicians: a study of cognitive and behavioural strategies in performance anxiety. *Br. J. Psychol.* 78(Pt. 2), 241–249. doi: 10.1111/j.2044-8295.1987.tb02243.x

Studer, R. K., Danuser, B., Wild, P., Hildebrandt, H., and Gomez, P. (2014). Psychophysiological activation during preparation, performance, and recovery in high- and low-anxious music students. *Appl. Psychophysiol. Biofeedback* 39, 45–57. doi: 10.1007/s10484-014-9240-2

Studer, R., Danuser, B., Hildebrandt, H., Arial, M., and Gomez, P. (2011a). Hyperventilation complaints in music performance anxiety among classical music students. *J. Psychosom. Res.* 70, 557–564. doi: 10.1016/j.jpsychores.2010.11.004

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011b). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Tan, J., Yap, K., and Bhattacharya, J. (2021). What does it take to flow? Investigating links between grit, growth mindset, and flow in musicians. *Music Sci.* 4, 1–11. doi: 10.1177/2059204321989529

Tief, V. J., and Gröpel, P. (2021). Pre-performance routines for music students: an experimental pilot study. *Psychol. Music* 49, 1261–1272. doi: 10.1177/0305735620953621

van Dixhoorn, J. (2007). "Whole-body breathing: a systems perspective on respiratory retraining," in *Principles and Practice of Stress Management*, 3rd Edn, eds P. M. Lehrer, R. L. Woolfolk, and W. E. Sime (New York, NY: Guilford Press), 291–332.

van Dixhoorn, J., and Duivenvoorden, H. J. (1985). Efficacy of Nijmegen Questionnaire in recognition of the hyperventilation syndrome. *J. Psychosom. Res.* 29, 199–206. doi: 10.1016/0022-3999(85)90042-x

van Kemenade, J. F., van Son, M. J., and van Heesch, N. C. (1995). Performance anxiety among professional musicians in symphonic orchestras: a self-report study. *Psychol. Rep.* 77, 555–562. doi: 10.2466/pr0.1995.77.2.555

Wells, R., Outhred, T., Heathers, J. A., Quintana, D. S., and Kemp, A. H. (2012). Matter over mind: a randomised-controlled trial of single-session biofeedback training on performance anxiety and heart rate variability in musicians. *PLoS One* 7:e46597. doi: 10.1371/journal.pone.0046597

Wesner, R. B., Noyes, R. Jr., and Davis, T. L. (1990). The occurrence of performance anxiety among musicians. *J. Affect. Disord.* 18, 177–185. doi: 10.1016/0165-0327(90)90034-6

Williamon, A., and Valentine, E. (2000). Quantity and quality of musical practice as predictors of performance quality. *Br. J. Psychol.* 91, 353–376. doi: 10.1348/000712600161871

Wilson, G. D. (2002). *Psychology for Performing Artists*, 2nd Edn. London: Whurr Publishers.

Wolfe, M. L. (1989). Correlates of adaptive and maladaptive musical performance anxiety. *Med. Probl. Perform. Art.* 4, 49–56.

Wong, Q. J. J., and Rapee, R. M. (2016). The aetiology and maintenance of social anxiety disorder: a synthesis of complimentary theoretical models and formulation of a new integrated model. *J. Affect. Disord.* 203, 84–100. doi: 10.1016/j.jad.2016.05.069

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009a). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Yoshie, M., Shigemasu, K., Kudo, K., and Ohtsuki, T. (2008). "Multidimensional anxiety and music performance: an exploratory application of the zones of optimal functioning model," in *Stress and Anxiety: Application to Life Span Development and Health Promotion*, eds P. Buchwald, T. Ringeisen, and M. W. Eysenck (Berlin: Logos Verlag Berlin GmbH), 163–171.

Yoshie, M., Shigemasu, K., Kudo, K., and Ohtsuki, T. (2009b). Effects of state anxiety on music performance: relationship between the Revised Competitive State Anxiety Inventory-2 subscales and piano performance. *Musicae Sci.* 13, 55–84. doi: 10.1177/102986490901300103

Zarza-Alzugaray, F. J., Casanova, O., McPherson, G. E., and Orejudo, S. (2020). Music self-efficacy for performance: an explanatory model based on social support. *Front. Psychol.* 11:1249. doi: 10.3389/fpsyg.2020.01249

Zarza-Alzugaray, F. J., Orejudo, S., Casanova, O., and Aparicio-Moreno, L. (2018). Music performance anxiety in adolescence and early adulthood: its relation with the age of onset in musical training. *Psychol. Music* 46, 18–32. doi: 10.1177/0305735617691592

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A Longitudinal Study of Physical and Mental Health and Health-Related Attitudes Among Music Students: Potentials and Challenges for University Health Promotion Programs

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Objective: Well-being of music students has been an increasing matter of concern since studies show that up to 50% of beginners suffer from playing-related pain or anxiety. The aim of this longitudinal study was to examine health status, health-related attitudes, behaviors, knowledge, skills, and coping strategies of students at the beginning of their education at a music university and at the end of their second semester.

Methods: Based on a longitudinal online survey conducted among students at a German music university since 2017, we investigated mental and physical health status, health-related attitudes, knowledge, skills, behaviors, and coping strategies of music students at the beginning of their first year ($n = 205$). We analyzed differences between performance and music education majors and between students playing different main instruments. In a subsample ($n = 62$), we additionally analyzed changes between the beginning of the music students' first and the end of their second semester, also depending on whether they attended courses on musicians' health.

Results: Music students are already in demand when they enter a music university, practicing on average almost 3 h daily. Compared to other body regions, pain in shoulders/back is most prevalent in first-year students, especially in those playing string instruments. Performance majors reported better knowledge about health risks and protective measures for musicians, better coping abilities, and practiced more than music education majors. First-year students assessed their overall and mental health status at the beginning of their first semester mainly as good, but we found a decrease in mental health status at the end of the second semester. After two semesters, students attending courses on musicians' health showed increased knowledge and skills regarding different aspects of musicians' health.

Conclusion: The health status of music students when they first enter a music university is still a concern. Information and practical courses enabling students to prevent overuse and cope with performing anxiety and other stressors are important components of a comprehensive study program. Knowledge about music students' needs can help conservatories better respond to the requirements and develop courses and measures supporting students from the beginning of their education.

Keywords: musicians' health, playing-related pain, mental health, performance studies, music education studies, music students, prevention

INTRODUCTION

The well-being of music students has been a longstanding matter of concern, since studies show that up to 50% of beginners suffer from playing-related pain or anxiety, mostly caused by stress and overuse (e.g., Fry, 1987; Lockwood, 1988; Zaza, 1992; Guptill et al., 2000). Generally, music students identify particularly with their choice of profession (Spahn et al., 2004) and have to deal with particular risk factors linked to their specific situation: (1) students start their professional training in childhood and adolescence, (2) playing music is linked to pleasure, strong emotions, and identity, (3) students frequently work at their physical and mental limits, (4) performing on stage in front of audiences, fellow students, and peers involves high societal pressure and frequently stress and anxiety, (5) the design of musical instruments is in many instances historical and implies unfavorable ergonomics (Spahn, 2006; Altenmüller and Jabusch, 2012).

Based on the specific challenges of studying music, it is not surprising that music students frequently suffer from medical conditions such as pain (Spahn et al., 2004; Williamon and Thompson, 2006; Spahn and Möller, 2011), performance anxiety (Williamon and Thompson, 2006; Spahn, 2011), and psychological problems, such as low self-esteem, dysfunctional perfectionism, and negative self-concept (Puls, 2004; Spahn et al., 2004; Zander et al., 2010). For instance, studies revealed that music students showed worse general health and worse physical health than amateur musicians (Antonini Philippe et al., 2019) and worse general health than university students of other disciplines (Spahn et al., 2004; Araújo et al., 2017).

Studying music involves rigorous daily practicing hours, and as a specific goal of the studies, performing under evaluative contexts, for example, during master classes and concerts. Music university education, therefore, needs to implement courses in order to prepare for auditions, public appearances, and other stressful evaluative situations. These may include virtual reality training of performances (Williamon et al., 2014), however, the basis is a comprehensive prevention program addressing bodily as well as psychological health, establishing awareness for health-related aspects, and impart practical knowledge concerning preventive health behavior.

Indeed, such preventive programs have been officially recommended in several countries, e.g., Germany (Spahn, 2006), the United States (Chesky et al., 2006), and the United Kingdom (e.g., Williamon and Thompson, 2006; Clark et al., 2013), and were systematically evaluated in some places, however, frequently with a small number of participants only. Spahn et al. (2001) investigated health outcomes following a weekly course of theoretic information about health-related behaviors and practical exercises in 22 music students and 22 controls. They showed improvements of playing-related pain symptoms, general symptom frequency, and emotional disturbances and anxiety levels. In a study by López and Martínez (2013) a course, focusing on health promotion and education about common medical problems, as well as on advice regarding posture, warm-up strategies, and effective prevention strategies was offered. Participants in the experimental group ($n = 90$) improved their body awareness by 91% and their injury rate decreased by 78%. Zander et al. (2010) demonstrated positive changes both for physical and psychological well-being after a health promotion course, however, in this study no control group was included. Generally, although sample sizes are mostly small (under 30), health prevention courses promoting healthy habits yield positive effects in many countries, e.g., the United States (Barton and Feinberg, 2008), South Africa (Panebianco-Warrens et al., 2015), or Iceland (Árnason et al., 2018).

In a study including 246 performance students from Manchester and London conservatories, Kreutz et al. (2008) focused on the musculoskeletal and nonmusculoskeletal health problems. They identified associations between health problems and behaviors and analyzed their relation to musical practice and performance. A high prevalence of musculoskeletal and nonmusculoskeletal problems was significantly impacting the perceived quality of practice. The authors conclude that the quality of musical practice and performance is threatened by a combination of problems specific to the upper extremities and spine as well as fatigue. In consequence, they propose the implementation of programs emphasizing the importance of physical fitness generally, paying particular attention to posture and the upper limbs, and focusing on the prevention of fatigue.

At the Hanover University of Music, Drama and Media, Germany, we have established and further developed such a program, beginning in 1994. First, a lecture entitled "The bodily and mental basis of healthy musicianship" was implemented, informing students about health issues and preventive strategies. This was supplemented by a musicians' clinic enabling students short-term, low-threshold access to a Performing Arts Medicine Specialist (author EA). In the late nineties, individual lessons in Feldenkrais and Alexander-technique were installed. From 2000 on, tutorials in small groups informing about preventive

strategies and techniques such as performance training in order to overcome performance anxiety were additionally offered. In 2002, a survey evaluated these programs and assessed the health status of the university's music students (Gräser, 2004). The results showed that a majority of students suffered from playing-related pain. Furthermore, most respondents rated the health-related offers as important or even very important (Gräser, 2004). The survey also found that those students who reported higher burdens, i.e., more and longer practice times, worse physical and mental health status, more frequent discomfort, were more likely to attend preventive courses at the university (Gräser, 2004). Thus, higher physical and mental demands lead to greater willingness to engage in programs regarding musicians' health. Integrating compulsory health classes in the curriculum can be a means to raise awareness, increase knowledge and skills regarding different aspects of musicians' health, and encourage music students to take preventive measures.

In such lectures and courses, music students can further be taught to rely on resources that are capable of positively influencing health and well-being, for instance, coping strategies, the individual importance that is ascribed to health, or striving to maintain a healthy lifestyle (Perkins et al., 2017). Here, the present Hanover program differs from programs established in other music universities in Germany and elsewhere (Grieco et al., 1989; Zander et al., 2010; Spahn et al., 2014; Matei and Ginsborg, 2021), since it is considerably more comprehensive. First, lectures and tutorials are compulsory courses for all bachelor students in performance and music education; however, students are free to take these required courses in any semester of their education. Furthermore, written exams and regular evaluations of the faculty assure quality of teaching. Second, it involves a peer-learning approach for the tutorials. Performance master students tutor bachelor students in small groups for 2 h weekly emphasizing the benefits of self-awareness, a healthy lifestyle, and avoidance of a no pain, no gain attitude. Thirdly, we institutionalized each semester small group practical courses ("laboratories") in an interdisciplinary atmosphere for 2 h twice a week, including bachelor and master students of all study programs (jazz, popular music, classical), focusing on "how to practice" and "how to overcome performance anxiety." For the former, each week, a student presents a "technical" problem, e.g., a particularly difficult passage, or high demands for endurance, speed, coordination etc., which then is discussed, and suggestions for solutions are presented. For the latter, students perform in front of each other under the guidance of a psychotherapist every week, with preliminary bodily and mental exercises and subsequent supervised performance evaluation. Finally, we offer a free, low-threshold face-to-face counseling service under medical confidentiality conditions by a MD, experienced in musician's medicine, neurology, and psychiatry (author EA) and a registered psychotherapist specialized for treatment of musicians, addressing health concerns, health behaviors, and general worries concerning the course of the studies, anxieties, and conflicts. Here, frequent issues are relationship problems, loneliness, professional pressures, and specific topics, such as usage of beta blockers to overcome performance anxiety, etc. During the coronavirus pandemic (which is not addressed in our study since the data have been collected before the pandemic), the latter was of vital importance for the well-being of students (Rosset et al., 2021).

Research Objectives

While the above mentioned research groups investigated health status of music students, thereby partially also taking a longitudinal perspective, the difference to our study lays in the sample size and most importantly in the quality of the intervention. A specific feature of our program is that courses are obligatory for performance and music education students and that they comprise peer-learning, "laboratories," and individual counseling. The present study adds to the current state of research by investigating at the same time not only the health status of music students when they first enter a music university but also health-related attitudes, behaviors, knowledge, and skills as well as their coping strategies and the development of these aspects over the course of the first two semesters as well as the impact of a comprehensive health prevention program.

Knowledge about the students' health status when they first enter a music university is critical to best address their needs early on in their music education. Additionally, we add a longitudinal perspective by examining how the health status evolves over the course of the music students' first year and what role attending courses on musicians' health plays. Analyzing the impact of the high demands of studying music and identifying vulnerable groups among first-year students can contribute to improving the preventive programs at music universities and help to address students in need of specific interventions.

The first aim of this study was to examine the health status as well as health-related aspects of music students when they first enter a music university. Therefore, our first research question is:

> *RQ1*: What are physical and mental health status, health-related attitudes, knowledge, skills, and behaviors, and coping strategies of music students at the beginning of their music university education?

The curriculum and requirements of performance classes differ from those of music education programs. Usually, performance majors concentrate on instrumental practice, supplemented with ear-training courses, music history, and orchestra and ensemble training. In contrast, music education majors practice their main instrument less and are more involved in the multi-instrumental practice, including singing, choir conducting, harmony classes, music history classes, improvisation, and theoretical pedagogical and research seminars. Therefore, students deciding to enroll in either of the programs may differ already before entering a music university, e.g., in their level of performance anxiety (e.g., Nawrocka et al., 2014):

> *H1*: Performance majors and music education majors differ regarding the aspects under investigation at the beginning of their studies.

We further focus on differences between instrument groups, since different instruments require a different amount of practice and challenge the body in different ways (e.g., Jørgensen, 2002):

> *H2*: Students playing different main instruments differ regarding the aspects under investigation at the beginning of their studies.

Since a further aim of our study is to explore the development of the health status after two semesters of training at a music university and the effect of courses on musicians' health, we include a longitudinal perspective. The second research question and the third hypothesis are concerned with the development of the aspects under investigation over the course of the first two semesters at a music university and differences depending on whether students attended courses on musicians' health. The hypothesis is founded in the results of the previous longitudinal studies reported above.

> *RQ2*: How do the aspects under investigation develop over the course of the first two semesters at a music university for students attending and not attending courses on musicians' health?

> *H3*: After two semesters at a music university, students attending courses on musicians' health show an improved health status and improved health-related attitudes, knowledge, and skills compared to students not taking courses on musicians' health.

MATERIALS AND METHODS

Since 2017, each year in the first month of the semester, an online survey was distributed *via* e-mail to all first-year bachelor students enrolled in performance training and music education training at a German music university. Performance training comprises the programs musical performance (classical), pianoforte, jazz and jazz-related music, and popular music. Music education training comprises the programs music performance and education, and an interdisciplinary bachelor's degree.

Additionally, we conducted follow-up studies at the end of each academic year to gain insights into the development of health status, health-related attitudes, and behaviors in the same cohorts. These follow-up studies were always conducted in the last month of the second semester. Since we wanted to capture the health status of first-year students in regular times and the coronavirus pandemic had intense effects and posed specific challenges for studying music that needs to be investigated in detail and, thereby, take specific determinants of the pandemic into account (see Rosset et al., 2021), we decided only to include the cohorts that started their music education in 2017, 2018, and 2019. For the longitudinal perspective, we included the follow-up surveys for the students that took up their studies in 2017 and 2018 and were surveyed again in 2018 and 2019, respectively. Correspondingly, for the longitudinal perspective, we excluded the first-year students who began their music studies in 2019 and were surveyed again in 2020 and we excluded the first-year students who began studying in 2020 and 2021 altogether.

Participants

The overall sample consisted of $n = 205$ first-year students: The first survey in 2017 was answered by 75 first-year students (response rate: 62%), the second in 2018 by 86 (response rate: 69%), and the third in 2019 by 44 (response rate: 35%). Of the overall 161 first-year students in 2017 and 2018, 62 answered the follow-up survey at the end of their second semester (2017: $n = 27$, 2018: $n = 35$). The longitudinal analyses were limited to the $n = 62$ students who completed both surveys at the beginning of their first semester and at the end of their second semester.

The survey was available in German and English, with 181 first-year respondents (88%) choosing the German version and 24 respondents (12%) the English version. In the follow-up survey, 58 respondents (94%) chose the German version and 4 (7%) the English version.

Procedure

The students were recruited *via* a mailing list including all first-year students. At the beginning of the online survey, the subject and purpose of the study and the voluntary nature of participation were explained, the anonymity and confidential handling of the data was assured, and the participants were informed that they could withdraw their consent to participate in the survey at any time. The participants gave their informed consent to take part in the study prior to entering the main survey. The study was approved by the joint ethics committee of the Leibniz University Hannover and the Hanover University of Music, Drama and Media (EV-LUH 9/2017). We furthermore adhere to the ethics regulations of our university according to the guidelines of the German Research Foundation and the Declaration of Helsinki. Participants were compensated for their time with 20 Euro.

Measures

The same measurements were used in all waves of the survey. Besides *gender*, *age*, *program of study*, *first citizenship*, and *main instrument* (which was later grouped into wind, keyboard, string, plucking, and percussion instruments, as well as voice and theoretical programs), the respondents were asked to self-assess their *overall health status* ("How would you describe your overall health?") on a five-point Likert-type scale (1 "very good" to 5 "very bad"). Respondents were also asked to indicate on a five-point Likert-type scale (1 "none at all" to 5 "very much") their perceived stress over the past week in eight different domains (e.g., "feeling fearful") to assess their *mental health status*. The items were taken from the eight-item symptom checklist (SCL-8), a short form of the SCL-25 measuring symptoms of depression and anxiety (Tambs and Røysamb, 2014). The scale showed high internal consistency in this study (first-year only: $\alpha = 0.86$; beginning of first semester and end of second semester: $\alpha = 0.88$) and the items were combined into a mean index with lower scores indicating better mental health status and higher scores indicating worse mental health status.

Based on frequency (0 "never," 1 "once every 6 months or fewer," 2 "more than once every 6 month, but not every month," 3 "monthly," 4 "more than once a month," 5 "constantly") and severity of *pain* (on a sliding scale from 0 "no pain at all" to 100 "very intense pain") in back and shoulders, arms and hands, mouth and jaw, and hearing, a composite pain score for each of the body regions was derived by multiplying the intensity of pain and the frequency of pain and dividing the product by ten (a similar score is used in the Pain Frequency-Severity-Duration Scale, PFSD, Salamon et al., 2014). The composite score can range from 0 to 50. Additionally, the respondents were asked to assess their playing-related impairments due to pain ("When you add all your pain together, how strongly does it affect you when you play music?") on a five-point scale (1 "not at all" to 5 "very strongly"). Additionally, the survey asked for *average daily practicing hours*.

The respondents were further asked to assess their perception of the *importance of health overall* ("How important is the general topic of health for you personally?") and of *health particularly for musicians* ("In your opinion, how important is health for musicians?") on a five-point scale (1 "not at all important" to 5 "very important").

Based on the scale from Dutta-Bergman (2004), *health consciousness* was measured with five items (e.g., "I actively try to prevent disease and illness," "Living life in the best possible health is very important to me.") on a five-point Likert-type scale (1 "strongly disagree" to 5 "strongly agree"). The scale showed sufficient internal consistency (first-year only: $\alpha = 0.63$; beginning of first semester and end of second semester: $\alpha = 0.66$) and the items were combined into a mean index.

The questionnaire further asked about the perceived *level of knowledge about health risks for musicians* ("How well-informed to do you feel about the various health risks associated with the occupation of being a musician?") and about *health protective measures for musicians* ("How well-informed do you feel about various methods of maintaining good personal health as a musician?") on a five-point Likert-type scale (1 "not at all" to 5 "very well").

Further, eight items asked about the *perceived level of knowledge and skills about different aspects of musicians' health* (relaxation methods, stress and time management, mental practice and memorization, body posture and movement, e.g., "How well-informed/competent do you feel about proper body posture and movement while singing/playing?"). All items were measured on a five-point Liker-type scale (1 "not at all" to 5 "very well") and combined into a mean index (first-year only: $\alpha = 0.74$; beginning of first semester and end of second semester: $\alpha = 0.73$).

Performance anxiety ("Performing situations make me nervous," "Performing situations make me feel uneasy," "Performing situations make me feel scared.") and *coping with performance anxiety* ("I feel capable of dealing with my nervousness in performing situations," "I feel capable of dealing with my uneasiness in performing situations," "I feel capable of dealing with my fear in performing situations.") were measured with three items, respectively, on a five-point Likert-type scale (1 "does not apply at all" to 5 "applies completely"). Both scales showed high internal consistency (first-year only: performance anxiety: $\alpha = 0.82$, coping with performance anxiety: $\alpha = 0.89$; beginning of first semester and end of second semester: performance anxiety: $\alpha = 0.78$, coping with performance anxiety: $\alpha = 0.88$) and the items were combined into a mean index for performance anxiety and for coping with performance anxiety, respectively.

Using the Stress and Coping Inventory (SCI; Satow, 2012), items regarding five different *coping strategies* were included (*social support*: e.g., "When I am stressed or under pressure, I find support from my partner or a good friend."; *positive thinking*: e.g., "I tell myself that stress and pressure also have positive effects"; *active coping*: e.g., "I do everything to prevent stress in the first place."; *faith*: e.g., "When I am stressed or under pressure, I find relief in my faith."; *alcohol and cigarettes*: e.g., "When I am stressed or under pressure I relax with a glass of wine or beer in the evening."). All five coping strategies were assessed with four items using a five-point Likert-type scale (1 "does not apply at all" to 5 "applies completely"). The five subscales showed sufficient internal consistencies (first-year only: social support: $\alpha = 0.76$, positive thinking: $\alpha = 0.62$, active coping: $\alpha = 0.73$, faith: $\alpha = 0.77$, alcohol and cigarettes: $\alpha = 0.77$; beginning of first semester and end of second semester: social support: $\alpha = 0.82$, positive thinking: $\alpha = 0.66$, active coping: $\alpha = 0.74$, faith: $\alpha = 0.82$, alcohol and cigarettes: $\alpha = 0.74$) and the items for each coping strategy were combined into a mean index.

In the follow-up survey, we further measured if the students had attended any courses on musicians' health in their first year. We separately assessed if they attended the lecture "the bodily and mental basis of healthy musicianship," the tutorial, or "laboratories" and combined the answers in one dichotomous variable indicating attendance in at least one course on musicians' health.

Data Analysis

All analyses were performed using SPSS (v. 28, Armonk, NY: IBM Corp.). Besides descriptive analyses of the sample using frequencies and percentages for categorical data and means (*M*) and standard deviations (*SD*) for numeric data, differences between performance majors and music education majors (H1), and between instrument groups (H2) were assessed using chi-square tests and multi-factor analyses of variance (ANOVAs) testing differences between majors and instrument groups in the same model, adjusting for gender, first citizenship, and cohort to control for the data collection in different years. We used G*Power (Faul et al., 2007) to determine the minimum effect sizes that could have been reliably detected based on our given sample size, $\alpha = 0.05$, and a desired power of 0.8 (sensitivity analysis). Based on these values, the minimum detectable effect size to determine differences between majors was $f = 0.20$ (equals approximately $\eta_p^2 = 0.04$) and $f = 0.26$ (equals approximately $\eta_p^2 = 0.06$) to assess differences between students playing different main instruments.

To analyze differences between the beginning of the first semester and the end of the second semester (RQ2),

TABLE 1 | Sample characteristics (performance majors and music education majors).

	Major						Total ($n = 205$)		
	Performance ($n = 71$, 35%)			Music education ($n = 134$, 65%)					
	n/M	%/SD	95% CI	n/M	%/SD	95% CI	n/M	%/SD	95% CI
Gender***									
Female	26	38%		88	66%		114	56%	
Male	43	62%		46	34%		89	43%	
Age	19.70	2.41	[19.13, 20.27]	20.19	2.63	[19.74, 20.64]	20.02	2.56	[19.67, 20.38]
First citizenship***									
German	47	67%		119	89%		166	81%	
Other	23	33%		15	11%		38	19%	
Main instrument									
Wind instruments	19	27%		32	24%		51	25%	
Keyboard instruments	9	13%		37	28%		46	22%	
String instruments (without plucking instruments)	18	26%		26	20%		44	22%	
Voice	8	11%		19	14%		27	13%	
Plucking instruments	9	13%		8	6%		17	8%	
Percussion instruments	6	9%		4	3%		10	5%	
Theoretical programs (composition, music theory)	1	1%		6	5%		7	4%	

*$n = 205$; CI = confidence interval; differences between performance majors and music education majors assessed using chi²-tests and ANOVA adjusted for cohort: ***$p \leq 0.001$. Gender: $\chi^2(1, n = 203) = 14.49$, $\varphi = -0.27$, $p \leq 0.001$; first citizenship: $\chi^2(1, n = 204) = 14.24$, $\varphi = -0.26$, $p \leq 0.001$; main instrument and age: n.s.*

we conducted repeated measures ANOVAs. For the repeated measures ANOVAs, sensitivity analysis with our given sample size of 62, $\alpha = 0.05$, and a desired power of 0.80 gives a minimum detectable effect size of $f = 0.18$ (equals approximately $\eta_p^2 = 0.03$). To analyze the interaction between time and group (H3), we conducted mixed ANOVAs. As dependent variables we used the aspects under investigation, as the within-subjects factor we used time (beginning of first semester vs. end of second semester at a music university), and as between-subjects factor we used the group (attending courses on musicians' health vs. not attending courses). For the mixed ANOVAs, sensitivity analysis showed a minimum detectable effect size of $f = 0.18$ (equals approximately $\eta_p^2 = 0.03$). In case of statistically significant interaction effects, simple main effects for both factors (using repeated measures ANOVA with separate groups for the within-subjects factor and one-way ANOVA for between-subjects factor) were determined.

RESULTS

Sample Characteristics

Of the overall sample of first-year students, 35% ($n = 71$) of the respondents were performance majors and 65% ($n = 134$) were music education majors (see **Table 1**). There were slightly more female students in the sample. Students in the sample were on average 20.02 years old and most had a German first citizenship. In the sample, 25% of the students played wind instruments as main instrument, 22% played keyboard instruments, 22% played string instruments, 13% sang, 8% played plucked instruments, 5% played percussion instruments, and 4% of the students were enrolled in composition or music theory.

Regarding the subsample of students who completed the survey at the beginning of their first semester as well as the follow-up survey at the end of their second semester ($n = 62$), the respondents were on average 20.47 years old, 66% were female, 66% were music education majors, while 34% were performance majors, and 81% of the respondents had a German first citizenship. Regarding their main instruments, 32% of the students played keyboard instruments, 31% played wind instruments, 16% played string instruments, 11% sang, 5% played plucked instruments, 3% played percussion instruments, and 2% was enrolled in composition or music theory. A comparison of the sample characteristics of the subsample of respondents from the cohorts of 2017 and 2018 at the beginning of their first semester as well as those who completed both surveys at the beginning of their first semester and at end of their second semester is provided in **Table 2**.

Health Status, Health-Related Attitudes, Knowledge, Skills and Behaviors, and Coping Strategies of Music Students at the Beginning of Their Education

The descriptive results were used to answer the first research question focusing on physical and mental health status and different health-related aspects as well as on coping strategies of music students at the beginning of their education at a music university (see **Table 3**). Students assessed their overall health status mainly as good ($M = 4.10$), with 55% ($n = 112$) reporting being in good and 28% ($n = 58$) even indicating being in very good health.

Regarding pain in different body regions, respondents reported the highest mean pain score in back and shoulders ($M = 14.10$, possible range of pain scores: 0 to 50), followed by arms and

TABLE 2 | Comparison of the sample characteristics of the subsample of respondents from the cohorts of 2017 and 2018.

	Survey					
	Beginning of first semester (n = 161)			End of second semester (n = 62)		
	n/M	%/SD	95% CI	n/M	%/SD	95% CI
Cohort						
2017	75	47%		27	44%	
2018	86	53%		35	57%	
Gender						
Female	84	52%		41	66%	
Male	76	47%		21	34%	
Age	20.04	2.59	[19.63, 20.44]	20.47	2.83	[19.75, 21.19]
Major						
Performance major	59	37%		21	34%	
Music education major	102	63%		41	66%	
First citizenship						
German	131	81%		50	81%	
Other	30	19%		12	19%	
Main instrument						
Wind instruments	41	26%		19	31%	
Keyboard instruments	38	24%		20	32%	
String instruments (without plucking instruments)	29	18%		10	16%	
Voice	22	14%		7	11%	
Plucking instruments	14	9%		3	5%	
Percussion instruments	10	6%		2	3%	
Theoretical programs (composition, music theory)	6	4%		1	2%	

CI = confidence interval.

hands ($M = 7.04$). This suggests the back and shoulder region as the most critical body region for first-year students, with 30% ($n = 62$) reporting having pain in back and/or shoulders more than once a month and 20% ($n = 40$) even indicated suffering from permanent pain in the back/shoulder area (see **Figure 1**). On average, the respondents showed medium scores with regards to the playing-related impairments they feel due to pain ($M = 2.83$).

On average, the respondents reported a good mental health status ($M = 2.29$, with lower values indicating better mental health status). However, the score for performance anxiety was slightly higher ($M = 3.12$).

On average, the respondents reported to be rather health conscious ($M = 3.98$) and ascribed high importance to health overall ($M = 4.45$) and especially to health for musicians ($M = 4.68$).

Concerning health-related knowledge and skills, respondents reported medium levels of knowledge regarding health risks ($M = 2.87$) and health protective measures for musicians ($M = 2.67$), and medium levels of knowledge and skills regarding different aspects of musicians' health ($M = 3.02$).

As an aspect of studying music which can influence the health status, we looked at the daily practicing time: On average, the respondents reported practicing 2.82 h daily (see **Table 3**).

Coping mechanisms are relevant to handle stressful times and there are various strategies to rely on during difficult situations. On average, the respondents reported to rely on social support as a coping strategy ($M = 3.91$), to a lower degree on positive thinking ($M = 3.22$), and active coping ($M = 2.97$). Faith ($M = 2.22$) as well as alcohol and cigarettes ($M = 1.72$) as coping mechanisms reach lower scores. Further, we assessed the respondents' perceptions of their ability to cope with performance anxiety, with results showing rather high self-assessed abilities ($M = 3.67$).

Differences Between Performance Majors and Music Education Majors

Since the study requirements for students enrolled in performance classes and those in music education training differ, we assumed differences between these two groups regarding the measures under investigation (H1; see **Table 3**).

Concerning sample characteristics, students enrolled in performance training differed from students in music education training regarding their gender, with performance majors having a higher rate of male students, and their first citizenship, with performance majors having a higher rate of students with another first citizenship than German (see **Table 1**). Therefore, gender and first citizenship were controlled in all ANOVAs to assess the differences between majors and instrument groups.

We found significant differences regarding the students' self-assessed knowledge about health risks [$F(1,181) = 6.72$, $p \leq 0.01$, $\eta_p^2 = 0.04$] and health protective measures for musicians [$F(1,182) = 5.93$, $p \leq 0.05$, $\eta_p^2 = 0.03$]: Students enrolled in performance programs reported better self-assessed knowledge in both domains (health risks: $M = 3.24$; protective measures: $M = 2.96$) than their fellow students in music education programs (health risks: $M = 2.68$; protective measures: $M = 2.51$). Additionally, there were significant differences regarding the

TABLE 3 | Health status, health-related attitudes, knowledge, skills and behaviors, and coping strategies of first-year music students (performance majors and music education majors).

	Major				Total ($n = 205$)	
	Performance ($n = 71$, 35%)		Music education ($n = 134$, 65%)			
	M (SD; min.-max.)	95% CI	M (SD; min.-max.)	95% CI	M (SD; min.-max.)	95% CI
Health status						
Self-assessed health status	4.10 (0.64; 3–5)	[3.95, 4.25]	4.10 (0.73; 2–5)	[3.97, 4.22]	4.10 (0.70; 2–5)	[4.00, 4.19]
Pain (frequency and intensity)						
Back/shoulders	12.92 (11.0; 0–40)	[10.29, 15.55]	14.72 (13.00; 0–48)	[12.50, 16.94]	14.10 (12.36; 0–48)	[12.40, 15.81]
Arms/hands	8.16 (10.40; 0–42)	[5.68, 10.64]	6.45 (8.38; 0–45)	[5.00, 7.89]	7.04 (9.15; 0–45)	[5.77, 8.31]
Mouth/jaw	4.92 (10.40; 0–42)	[2.71, 7.12]	3.69 (8.25; 0–50)	[2.27, 5.11]	4.11 (8.60; 0–50)	[2.92, 5.31]
Hearing	2.34 (6.15; 0–35)	[0.86, 3.81]	2.00 (5.63; 0–43)	[1.03, 2.96]	2.11 (5.80; 0–43)	[1.31, 2.92]
Playing-related impairments due to pain	2.83 (1.03; 1–5)	[2.58, 3.09]	2.62 (0.99; 1–5)	[2.45, 2.79]	2.69 (1.01; 1–5)	[2.55, 2.84]
Mental health status	2.14 (0.74; 1–4)	[1.96, 2.32]	2.37 (0.89; 1–5)	[2.21, 2.52]	2.29 (0.85; 1–5)	[2.17, 2.41]
Performance anxiety	2.89 (1.07; 1–5)	[2.64, 3.15]	3.24 (1.03; 1–5)	[3.07, 3.42]	3.12 (1.05; 1–5)	[2.98, 3.27]
Health-related attitudes						
Health consciousness	4.04 (0.53; 3–5)	[3.92, 4.17]	3.94 (0.54; 2–5)	[3.85, 4.04]	3.98 (0.54; 2–5)	[3.90, 4.05]
Importance of health overall	4.49 (0.65; 3–5)	[4.34, 4.65]	4.43 (0.74; 2–5)	[4.30, 4.55]	4.45 (0.71; 2–5)	[4.35, 4.55]
Importance of health for musicians	4.62 (0.70; 2–5)	[4.45, 4.79]	4.71 (0.53; 3–5)	[4.62, 4.80]	4.68 (0.60; 2–5)	[4.60, 4.76]
Self-assessed health-related knowledge and skills						
Knowledge health risks for musicians***	3.24 (0.96; 1–5)	[3.02, 3.47]	2.68 (0.88; 1–5)	[2.53, 2.83]	2.87 (0.94; 1–5)	[2.74, 3.00]
Knowledge health protective measures for musicians**	2.96 (1.03; 1–5)	[2.71, 3.20]	2.51 (0.85; 1–5)	[2.37, 2.66]	2.67 (0.94; 1–5)	[2.54, 2.80]
Knowledge and skills regarding different aspects of musicians' health	3.07 (0.62; 1–5)	[2.92, 3.22]	2.99 (0.56; 1–4)	[2.99, 3.09]	3.02 (0.58; 1–5)	[2.94, 3.10]
Health-related behaviors						
Average daily practicing hours***	3.69 (1.47; 1–8)	[3.34, 4.05]	2.37 (1.05; 1–6)	[2.19, 2.55]	2.82 (1.36; 1–8)	[2.63, 3.01]
Coping strategies						
Coping with performance anxiety*	3.96 (0.86; 1–5)	[3.75, 4.16]	3.53 (0.91; 1–5)	[3.37, 3.68]	3.67 (0.91; 1–5)	[3.55, 3.80]
Social support as coping strategy	3.79 (0.94; 1–5)	[3.56, 4.01]	3.89 (0.83; 1–5)	[3.83, 4.12]	3.91 (0.87; 1–5)	[3.79, 4.03]
Positive thinking as coping strategy	3.36 (0.74; 2–5)	[3.18, 3.53]	3.15 (0.96; 1–5)	[2.99, 3.32]	3.22 (0.90; 1–5)	[3.10, 3.35]
Active coping as coping strategy	2.93 (0.85; 1–5)	[2.73, 3.13]	2.99 (0.85; 1–5)	[2.85, 3.14]	2.97 (0.85; 1–5)	[2.86, 3.09]
Faith as coping strategy	2.11 (1.00; 1–5)	[1.87, 2.35]	2.27 (1.18; 1–5)	[2.07, 2.47]	2.22 (1.12; 1–5)	[2.06, 2.37]
Alcohol and cigarettes as coping strategy	1.95 (1.09; 1–5)	[1.69, 2.21]	1.60 (0.84; 1–5)	[1.45, 1.74]	1.72 (0.95; 1–5)	[1.59, 1.85]

*$n = 205$ ($n_{performance\ major} = 71$; $n_{music\ education\ major} = 134$); CI = confidence interval; differences between performance majors and music education majors assessed using ANOVAs adjusted for instrument group, cohort, gender, and first citizenship: ***$p \leq 0.001$, **$p \leq 0.01$, *$p \leq 0.05$. Knowledge level health risks for musicians: $F(1,181) = 6.72$, $p \leq 0.01$, $\eta_p^2 = 0.04$; knowledge level health protective measures for musicians: $F(1,182) = 5.93$, $p \leq 0.05$, $\eta_p^2 = 0.03$; average daily practicing hours: $F(1,178) = 16.96$, $p \leq 0.001$, $\eta_p^2 = 0.09$; coping with performance anxiety: $F(1,181) = 9.19$, $p \leq 0.01$, $\eta_p^2 = 0.05$; others: n.s.*

average daily practicing hours [$F(1,178) = 16.96$, $p \leq 0.001$, $\eta_p^2 = 0.09$]: While performance majors on average practiced about 3.69 h per day, music education majors practiced on average 2.37 h daily. Finally, performance majors and music education majors also differed significantly regarding their abilities to cope with performance anxiety [$F(1,181) = 9.19$, $p \leq 0.01$, $\eta_p^2 = 0.05$], with performance majors ($M = 3.96$) reporting better coping abilities than music education majors ($M = 3.53$).

There were no statistically significant differences between performance majors and music education majors regarding the other variables under investigation. Accordingly, the first hypothesis was only partially supported.

Differences Between Instrument Groups

Besides differences between students enrolled in performance or in music education training, we also assumed differences between students playing different main instruments regarding the aspects under investigation (H2). Regarding sample characteristics, there were no significant differences between students playing different main instruments regarding field of study, first citizenship, and age, but regarding gender [$\chi^2(6, n = 200) = 28.93$, Cramer's $V = 0.38$, $p \leq 0.001$], with voice having the highest share of female students ($n = 21$, 78%), followed by string instruments ($n = 32$, 76%), and wind instruments ($n = 28$, 55%), while percussion instruments had the highest share of male students ($n = 9$, 90%), followed by theoretical programs without main instrument ($n = 5$, 71%), plucking instruments ($n = 12$, 71%), and keyboard instruments ($n = 24$, 52%).

Students with different main instruments differed significantly regarding their average daily practicing hours [$F(6,178) = 3.24$, $p \leq 0.05$, $\eta_p^2 = 0.10$]. A Bonferroni-corrected post-hoc test showed that students studying theoretical programs without main instruments practiced less ($M = 1.33$, $SD = 0.52$) than students playing string instruments ($M = 3.36$, $SD = 1.58$, $p \leq 0.01$), students playing percussion instruments ($M = 3.30$,

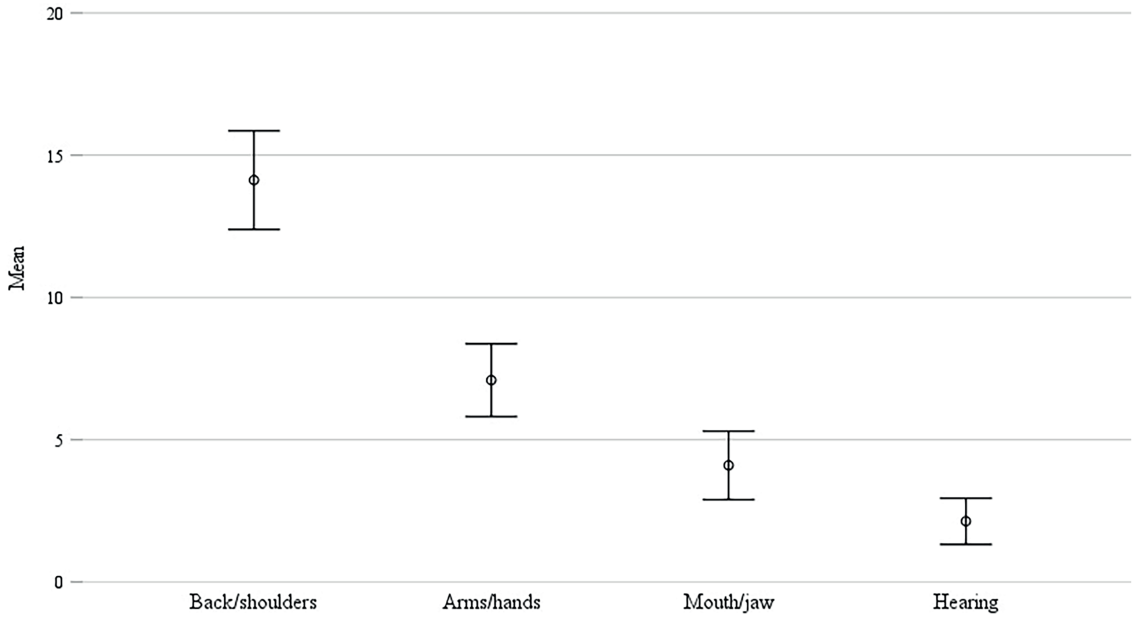

FIGURE 1 | Mean of the pain score (function of frequency and severity of pain; range 0–50) in the respective body parts ($n = 205$; error bars represent 95% CI).

$SD = 1.57$, $p \leq 0.05$), and students playing keyboard instruments ($M = 2.84$, $SD = 1.33$, $p \leq 0.01$).

Moreover, back/shoulder pain [$F(6,181) = 2.34$, $p \leq 0.05$, $\eta_p^2 = 0.07$] and pain in the mouth/jaw [$F(6,179) = 3.16$, $p \leq 0.01$, $\eta_p^2 = 0.10$] differed significantly between the instrument groups. A Bonferroni post-hoc analysis revealed that students playing string instruments ($M = 19.65$, $SD = 1.58$) reported significantly more frequent and intense back/shoulder pain than students who sang ($M = 9.23$, $SD = 10.27$, $p \leq 0.05$) and students playing wind instruments reported significantly greater pain in the mouth/jaw ($M = 8.05$, $SD = 10.89$) than students playing keyboard instruments ($M = 2.40$, $SD = 8.60$, $p \leq 0.05$). There were no statistically significant differences between students playing different main instruments regarding the other variables under investigation. Like the first hypothesis, the second hypothesis was only partially supported.

Development of the Aspects Under Investigation Over the Course of the First Two Semesters at a Music University

To answer the second research question, we assessed differences of the subsample of first-year music students from the cohorts of 2017 and 2018 that completed the survey both at the beginning of their first semester and at the end of their second semester. We analyzed changes in the aspects under investigation over the course of their first two semesters at a music university using repeated measures ANOVAs (see **Table 4**).

The results showed that the students' mental health status was significantly worse at the end of the second semester at a music university [$F(1.59) = 8.49$, $p \leq 0.01$, $\eta_p^2 = 0.13$; $M_{\text{beginning first semester}} = 2.28$, $M_{\text{end second semester}} = 2.60$, with lower values indicating better mental health status).

However, self-assessed knowledge about health protective measures for musicians increased significantly from the beginning of the music university education to the end of the second semester [$F(1.61) = 7.50$, $p \leq 0.01$, $\eta_p^2 = 0.11$, $M_{\text{beginning first semester}} = 2.71$, $M_{\text{end second semester}} = 3.05$] and there was also a small but significant increase between time points concerning the self-assessment of knowledge and skills regarding different aspects of musicians'health [$F(1.61) = 4.29$, $p \leq 0.05$, $\eta_p^2 = 0.07$; $M_{\text{beginning first semester}} = 2.97$, $M_{\text{end second semester}} = 3.16$].

There were no statistically significant differences between the beginning of the first semester and the end of the second semester regarding the other variables under investigation.

Differences Over the Course of the First Two Semesters at a Music University Between Students Taking Courses on Musicians' Health and Students Not Taking Courses

To test H3, we looked at the interactions between students attending or not attending courses on musicians' health and the development of the aspects under investigation over time (group x time). **Table 4** provides an overview of the mean scores of the variables under investigation for students who attended courses on musicians' health ($n = 20$, 32%) and those who did not ($n = 42$, 68%) at the beginning of their first semester and at the end of their second semester.

TABLE 4 | Development of health status, health-related attitudes, knowledge, skills and behaviors, and coping strategies over the course of the first two semesters at a music university (students attending and not attending courses on musicians' health).

	Total				Attending courses ($n = 20$, 32%)				Not attending courses ($n = 42$, 68%)			
	Beginning of first semester		End of second semester		Beginning of first semester		End of second semester		Beginning of first semester		End of second semester	
	M (SD)	95% CI	M (SD)	95% CI	M (SD)	95% CI	M (SD)	95% CI	M (SD)	95% CI	M (SD)	95% CI
Health status												
Self-assessed health status	3.98 (0.72)	[3.80, 4.17]	4.00 (0.77)	[3.80, 4.20]	4.05 (0.69)	[3.73, 4.37]	4.15 (0.75)	[3.80, 4.50]	3.95 (0.74)	[3.72, 4.18]	3.93 (0.79)	[3.68, 4.18]
Pain (frequency and intensity)												
Back/shoulders	15.20 (12.86)	[11.94, 18.47]	14.61 (11.40)	[11.72, 17.51]	12.00 (11.84)	[6.45, 17.54]	10.27 (9.41)	[5.86, 14.67]	16.73 (13.18)	[12.62, 20.84]	16.68 (11.77)	[13.02, 20.35]
Arms/hands	7.25 (8.68)	[5.01, 9.49]	7.73 (9.74)	[5.26, 10.20]	8.17 (10.10)	[3.44, 12.89]	7.60 (9.02)	[3.38, 11.82]	6.80 (7.98)	[4.24, 9.35]	7.79 (10.17)	[4.62, 10.96]
Mouth/jaw	6.15 (12.26)	[3.01, 9.29]	5.17 (8.81)	[2.94, 7.41]	3.72 (8.58)	[−0.30, 7.74]	2.34 (5.83)	[−0.38, 5.07]	7.33 (13.64)	[3.03, 11.64	6.52 (9.68)	[3.50, 9.54]
Hearing	3.20 (8.04)	[1.14, 5.26]	3.18 (7.12)	[1.38, 4.99]	3.81 (7.77)	[0,17, 7.45]	4.01 (6.23)	[1.06, 6.95]	2.90 (8.24)	[0.30, 5.50]	2.79 (7.52)	[0.45, 5.14]
Playing-related impairments due to pain	2.75 (0.82)	[2.53, 2.96]	2.78 (0.94)	[2.54, 3.03]	2.84 (0.83)	[2.44, 3.24]	2.90 (0.79)	[2.53, 3.27]	2.70 (0.82)	[2.44, 2.96]	2.73 (1.01)	[2.40, 3.05]
Mental health status**	2.28 (0.90)	[2.04, 2.51]	2.61 (0.82)	[2.40, 2.82]	2.11 (0.71)	[1.77, 2.45]	2.18 (0.71)	[1.85, 2.51]	2.35 (0.97)	[2.05, 2.66]	2.82 (0.80)	[2.57, 3.07]
Performance anxiety	3.22 (0.99)	[2.96, 3.47]	3.02 (0.98)	[2.77, 3.27]	2.88 (0.95)	[2.44, 3.33]	2.65 (0.88)	[2.24, 3.06]	3.38 (0.99)	[3.07, 3.69]	3.20 (0.98)	[2.89, 3.50]
Health-related attitudes												
Health consciousness	3.99 (0.49)	[3.87, 4.11]	4.01 (0.58)	[3.86, 4.16]	4.07 (0.50)	[3.84, 4.30]	4.01 (0.61)	[3.73, 4.29]	3.95 (0.48)	[3.80, 4.10]	4.01 (0.58)	[3.83, 4.19]
Importance of health overall	4.45 (0.72)	[4.27, 4.63]	4.55 (0.62)	[4.39, 4.71]	4.50 (0.69)	[4.18, 4.82]	4.55 (0.51)	[4.31, 4.79]	4.43 (0.74)	[4.20, 4.66]	4.55 (0.67)	[4.34, 4.76]
Importance of health for musicians	4.63 (0.63)	[4.47, 4.79]	4.68 (0.72)	[4.49, 4.86]	4.50 (0.83)	[4.11, 4.89]	4.65 (0.93)	[4.21, 5.09]	4.69 (0.52)	[4.53, 4.85]	4.69 (0.60)	[4.50, 4.77]
Health-related knowledge and skills												
Knowledge health risks for musicians	2.89 (0.89)	[2.66, 3.11]	3.02 (0.93)	[2.78, 3.25]	3.30 (0.87)	[2.90, 3.70]	3.80 (0.83)	[3.41, 4.19]	2.69 (0.84)	[2.43, 2.95]	2.64 (0.73)	[2.42, 2.87]
Knowledge health protective measures for musicians**	2.71 (0.95)	[2.47, 2.95]	3.05 (0.97)	[2.80, 3.29]	3.10 (0.91)	[2.67, 3.53]	3.80 (0.83)	[3.41, 4.19]	2.52 (0.92)	[2.24, 2.81]	2.69 (0.81)	[2.44, 2.94]
Knowledge and skills regarding different aspects of musicians' health*	2.97 (0.55)	[2.83, 3.11]	3.16 (0.50)	[3.03, 3.28]	2.94 (0.68)	[2.63, 3.26]	3.46 (0.46)	[3.25, 3.68]	2.99 (0.49)	[2.84, 3.14]	3.01 (0.45)	[2.87, 3.15]
Health-related behaviors												
Average daily practicing hours	2.77 (1.35)	[2.43, 3.12]	2.89 (1.30)	[2.56, 3.22]	3.84 (1.21)	[3.26, 4.43]	4.00 (1.05)	[3.52, 4.48]	2.29 (1.11)	[1.94, 2.63]	2.36 (1.10)	[2.03, 2.69]
Coping strategies												
Coping with performance anxiety	3.46 (0.99)	[3.21, 3.72]	3.58 (0.93)	[3.35, 3.82]	3.38 (0.96)	[2.94, 3.83]	3.70 (0.98)	[3.24, 4.16]	3.50 (1.02)	[3.18, 3.82]	3.53 (0.91)	[3.24, 3.82]
Social support as coping strategy	3.96 (0.86)	[3.74, 4.18]	3.97 (0.85)	[3.75, 4.19]	3.69 (0.99)	[3.22, 4.15]	3.64 (0.95)	[3.19, 4.08]	4.09 (0.78)	[3.85, 4.33]	4.13 (0.76)	[3.89, 4.36]
Positive thinking as coping strategy	3.17 (0.93)	[2.93, 3.40]	3.21 (0.79)	[3.01, 3.41]	3.35 (0.75)	[3.00, 3.70]	3.09 (0.59)	[2.81, 3.36]	3.08 (1.00)	[2.77, 3.39]	3.27 (0.87)	[3.00, 3.55]
Active coping as coping strategy	2.98 (0.75)	[2.79, 3.17]	2.86 (0.75)	[2.67, 3.05]	3.04 (0.83)	[2.65, 3.43]	2.90 (0.81)	[2.53, 3.28]	2.95 (0.72)	[2.73, 3.18]	2.84 (0.73)	[2.61, 3.07]
Faith as coping strategy	2.33 (1.09)	[2.05, 2.61]	2.46 (0.94)	[2.22, 2.70]	2.47 (1.24)	[1.89, 3.05]	2.48 (0.95)	[2.03, 2.92]	2.27 (1.02)	[1.95, 2.59]	2.45 (0.94)	[2.15, 2.74]
Alcohol and cigarettes as coping strategy	1.63 (0.91)	[1.40, 1.86]	1.51 (0.69)	[1.33, 1.68]	1.78 (1.09)	[1.26, 2.29]	1.46 (0.56)	[1.20, 1.73]	1.57 (0.81)	[1.31, 1.82]	1.53 (0.74)	[1.30, 1.76]

*$n = 62$; CI = confidence interval; differences between beginning of first semester and end of second semester assessed using repeated measures ANOVAs: **$p \leq 0.01$, *$p \leq 0.05$. Mental health status: $F(1.59) = 8.49$, $p \leq 0.01$, $\eta_p^2 = 0.13$; knowledge level health protective measures for musicians: $F(1.61) = 7.50$, $p \leq 0.01$, $\eta_p^2 = 0.11$; assessment of knowledge and skills regarding different aspects of musicians'health $F(1.61) = 4.29$, $p \leq 0.05$, $\eta_p^2 = 0.07$; others: n.s.*

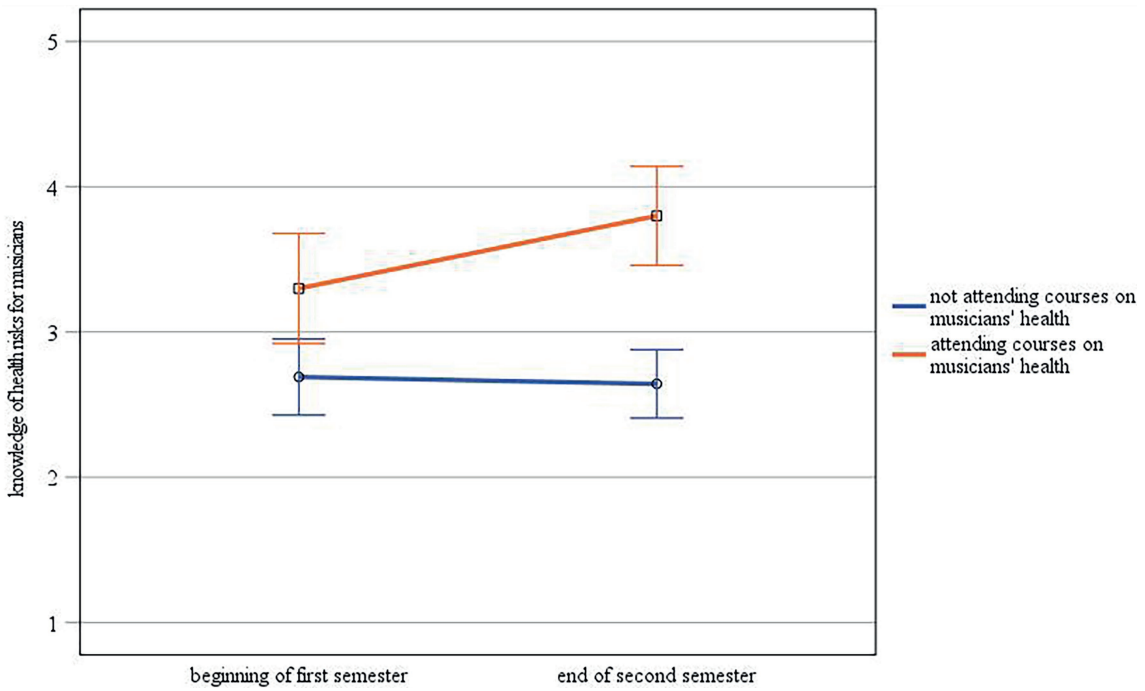

FIGURE 2 | Interaction between time and group regarding self-assessment of knowledge about health risks for musicians (error bars represent 95% CI).

Regarding the self-assessed knowledge of health risks for musicians, there was a statistically significant interaction between time and group [$F(1.60) = 4.03$, $p \leq 0.05$, $\eta_p^2 = 0.06$; see **Figure 2**]. A one-way ANOVA to test the main effect of group showed significant differences between students taking courses on musicians' health and those students who did not both at the beginning [$F(1.60) = 7.00$, $p \leq 0.01$, $\eta_p^2 = 0.10$] and at the end of the semester [$F(1.60) = 31.24$, $p \leq 0.001$, $\eta_p^2 = 0.34$], with students having attended musicians' health-related courses reporting higher knowledge levels at both time points (beginning of first semester: $M_{\text{attending courses}} = 3.30$, $M_{\text{not attending courses}} = 2.69$; end of second semester: $M_{\text{attending courses}} = 3.80$, $M_{\text{not attending courses}} = 2.64$). Repeated measures ANOVA to test the main effect of time showed that there was no main effect for time on knowledge of health risks for musicians neither for students taking courses [$F(1.19) = 3.52$, $p = 0.08$, $\eta_p^2 = 0.16$] nor for students not taking courses [$F(1.41) = 0.12$, $p = 0.74$, $\eta_p^2 = 0.00$].

Regarding self-assessed knowledge about health protective measures for musicians, there was a statistically significant interaction between time and group [$F(1.60) = 4.28$, $p \leq 0.05$, $\eta_p^2 = 0.07$; see **Figure 3**]. A one-way ANOVA showed that knowledge about health protective measures for musicians was significantly higher for students taking courses on musicians' health than for those students who did not both at the beginning [$F(1.60) = 5.37$, $p \leq 0.05$, $\eta_p^2 = 0.08$; $M_{\text{attending courses}} = 3.10$, $M_{\text{not attending courses}} = 2.52$] and at the end of the semester [$F(1.60) = 24.91$, $p \leq 0.001$, $\eta_p^2 = 0.29$; $M_{\text{attending courses}} = 3.80$, $M_{\text{not attending courses}} = 2.69$]. As reported above, we found a significant difference between time points. A further repeated measures ANOVA with separate examination of the two groups revealed that there was a statistically significant effect of time on knowledge about health protective measure only for the group of students who were taking courses on musicians' health, [$F(1.19) = 9.22$, $p \leq 0.01$, $\eta_p^2 = 0.33$] but not for the group who did not attend courses [$F(1.41) = 1.41$, $p = 0.24$, $\eta_p^2 = 0.03$], with students attending courses on musicians health showing an increase in knowledge at the end of the second semester compared to the beginning of the first semester.

Finally, there was a statistically significant interaction between time and group concerning the self-assessment of knowledge and skills regarding different aspects of musicians' health [$F(1.60) = 7.85$, $p \leq 0.01$, $\eta_p^2 = 0.12$; see **Figure 4**]. A one-way ANOVA showed that the assessment of knowledge and skills regarding different aspects of musicians' health differed significantly between students who took courses on musicians' health and those students who did not at the end of the second semester [$F(1.60) = 13.39$, $p \leq 0.001$, $\eta_p^2 = 0.18$] but not at the beginning of the first year [$F(1.60) = 0.09$, $p = 0.77$, $\eta_p^2 = 0.00$]. In the analysis reported above, we found significant differences between time points. A repeated measures ANOVA with separate examination of the two groups further revealed a statistically significant simple main effect of time on knowledge and skills regarding different aspects of musicians' health for the group of students who were attending courses on musicians' health [$F(1.19) = 7.50$, $p \leq 0.05$, $\eta_p^2 = 0.28$], who assessed their knowledge and skills as higher at the end of their second semester ($M = 3.46$) compared to the beginning of their

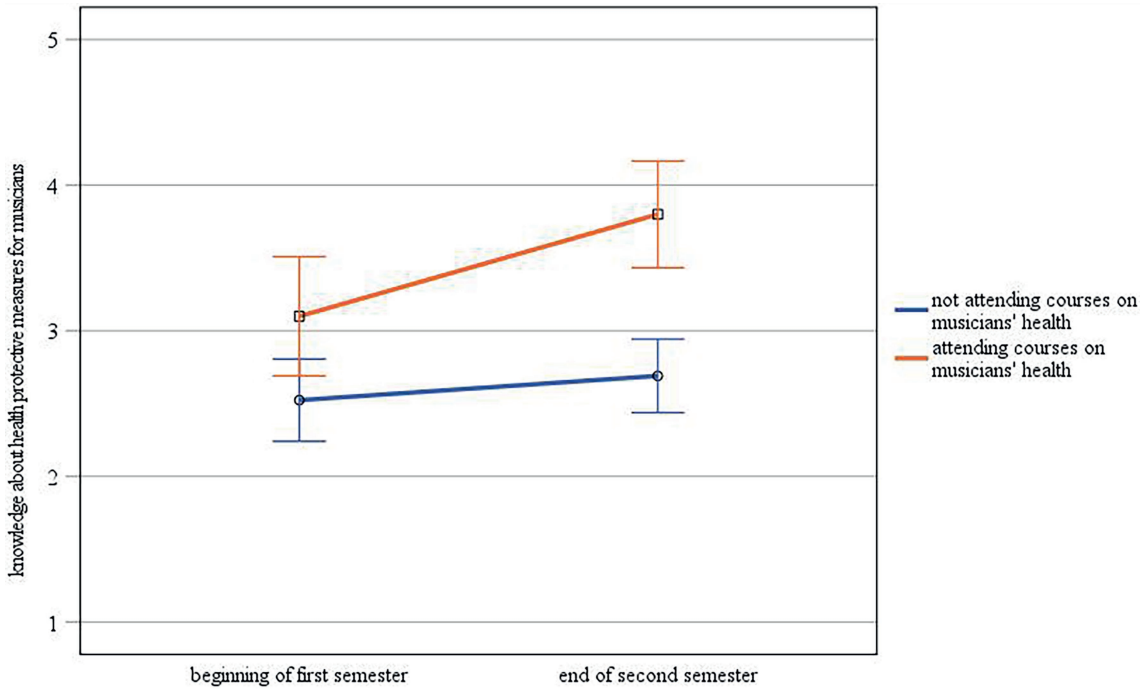

FIGURE 3 | Interaction between time and group regarding self-assessment of knowledge about health protective measures for musicians (error bars represent 95% CI).

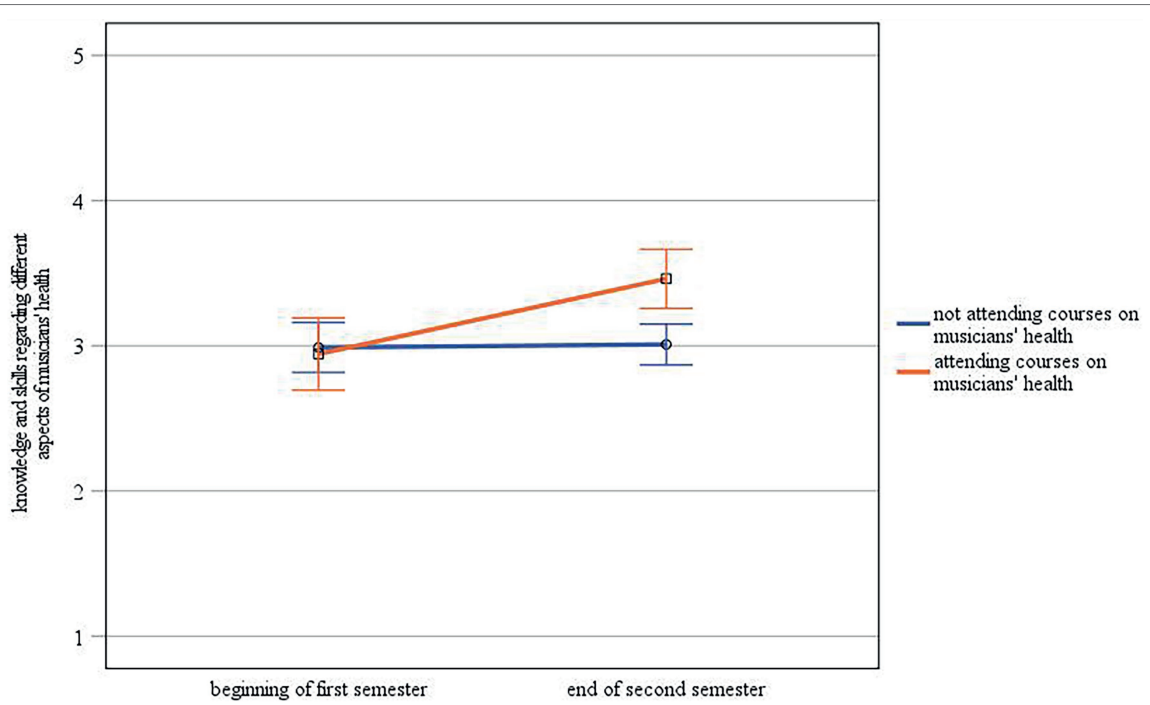

FIGURE 4 | Interaction between time and group concerning self-assessment of knowledge and skills regarding different aspects of musicians' health (error bars represent 95% CI).

first semester ($M = 2.94$), but not for the group who did not attend such courses [$F(1.41) = 0.06$, $p = 0.80$, $\eta_p^2 = 0.00$; $M_{\text{beginning first semester}} = 2.99$, $M_{\text{end second semester}} = 3.01$].

There were no statistically significant interaction effects regarding the other variables under investigation. Accordingly, the third hypothesis could only be supported with regard to

health-related knowledge and skills, but not with regard to health status and health-related attitudes.

DISCUSSION

Health is an important issue for music students. To address their specific needs, it is essential to know their health status, health-relevant attitudes and behaviors when they first enter a music university. Therefore, the aim of our study was to examine the physical and mental health status of first-year music students, their health-related attitudes, knowledge, skills, and behaviors, and their coping strategies. In doing so, we also investigated differences between performance and music education majors as well as differences between students playing different main instruments. Additionally, we aimed to analyze how these aspects under investigation changed during the first two semesters at a music university and whether there were differences over time between students who attended courses on musicians' health and students who did not attend such courses.

Concerning H1, unexpectedly our study revealed little differences in health status and health-related attitudes between performance majors and music education majors. Although music performance majors practiced more than one hour more per day as compared to music education majors, both groups show a similar occurrence of pain syndromes and performance anxiety. However, compared to the large studies of Spahn et al. (2004), Kreutz et al. (2009), and Brandfonbrener (2009), the students assessed their overall health status and their mental health status at the beginning of their first semester better and mainly as good.

In line with previous research (Williamon and Thompson, 2006), our results show that the back and shoulder region is the most critical body region for first-year students regarding pain. This is especially true for students playing string instruments, which is in line with studies showing that professional string players experience physical problems more frequently (Gembris et al., 2018). Students playing violin and viola have ergonomically greater physical strains due to the playing posture as compared to other instrumentalists (Steinmetz et al., 2015). As one would expect, our results further showed a trend that students playing wind instruments suffered more from pain in the mouth/jaw than students playing other main instruments. However, regarding H2, differences in health status between students playing different main instruments were not significant.

As reported in previous findings (e.g., Perkins et al., 2017), music students seem to know the importance of health for musicians and reported an increased health consciousness. However, their perceived knowledge regarding health risks and health protective measures was a little less pronounced but still on a medium level. Students enrolled in performance programs self-assessed their knowledge about health risks and protective behaviors as better than their fellow students enrolled in education training. This difference underlines that performance majors, who also practiced on average about 1,5 h more per day, may have already encountered health problems and are, thus, more aware of the risks for musicians (Gembris et al., 2020). Furthermore, their peers might more frequently address preventive measures, warm-ups, and practice techniques. On the one hand, these findings underline the concern students show about their health from an early point in their education on, on the other hand, these findings point to the importance of considering different needs of different majors when teaching music students techniques and measures to maintain their health. It should be mentioned, that 30% of adolescent high performing musicians suffering from injury or playing-related pain feel not taken seriously by their instrumental teachers (Gembris et al., 2020). Concerning university students, our assumption that performance majors and music education majors differ regarding the aspects under investigation was only supported regarding self-assessed knowledge about health risks and health protective measures for musicians, the average daily practicing hours, and abilities to cope with performance anxiety. With regard to the latter, it was shown that performance majors assessed their abilities to cope with performance anxiety as better than music education majors. Here, probably a selection bias has to be assumed, since students suffering from performance anxiety tend to display avoidance behavior and might chose programs implying fewer public appearances (Schneider and Chesky, 2011). This can be remediated by early interventions in music schools targeted at overcoming music performance anxiety already early in the career (Braden et al., 2015).

As a positive outcome, and in contrast to previous research showing music students' poor use of coping strategies (Araújo et al., 2017), the first-year students in our sample reported healthy coping strategies, with social support and positive thinking as the most used strategies. Concerning RQ2, the results are overall in line with previous research: Comparable to Zander et al. (2010), we found a decrease in music students' mental health status over the course of the first two semesters at a music university. Students still reported medium mental health scores at the end of their second semester, however, a worsened mental health status is concerning. Decline in mental health status might also be due to the changes involved in starting studying at a university, often accompanied by leaving the childhood home – often the hometown or even country – and having to become more independent. But since this result is in line with studies showing that music students particularly suffer from mental distress (e.g., Wristen, 2013), the decrease in mental health status might also be due to musician specific factors such as high demands, high ambitions, high level of competition and specific stressors linked to adaptation to new teachers, and new practice habits. In line with this, Hildebrandt et al. (2012) found an increase of fatigue, depression, and stage fright during the first year of high-level education in a Swiss music university.

Regarding H3, the results concerning the effects of attending the comprehensive health program were disappointing. The small sample of 20 students taking the courses can be explained by the fact that students are free to attend these obligatory courses at any semester of their education, and, thus, seem to postpone them to a later timepoint, after the second semester.

This has two reasons: first, in their first two semesters, students want to concentrate on improving their instrumental skills since they are afraid to disappoint their teachers. Second, non-German-speaking students tend to choose these courses at a later timepoint, when they have improved their language skills.

Comparing the development of the aspects under investigation in the 20 students having attended courses on musicians' health in their first two semesters to the 42 students having not attended, our results point toward a potentially health-enhancing impact of such courses. The findings showed that self-assessed knowledge about health protective measures for musicians as well as self-assessed knowledge and skills regarding different aspects of musicians' health was significantly better at the end of the second semester compared to the beginning of the first semester for those students attending courses on musicians' health. However, neither pain, playing-related impairments due to pain nor general or mental health status or performance anxiety was improved at the end of the second semester in course taking students. A possible explanation could be, that students at risk may have chosen the courses, and thus prevented a deterioration of their health status. Generally, selection biases of such courses among those who are already sensitized play a role here and are described also by other researchers when drawing non-randomized samples (e.g., Spahn et al., 2004). In any case, studies under controlled conditions are necessary to investigate the causal effects of such courses; especially studies examining health-related attitudes, for which we found no differences between students who attended courses on musicians' health and those who did not. But since attitudes are important predictors of actual behavior, changing attitudes that may then translate into behavior is also a relevant outcome measure of such courses (e.g., Link et al., 2021). Additionally, future studies should consider further time points to explore long-term effects of courses on musicians' health.

Our findings also showed that students attending courses on musicians' health assessed their knowledge of health risks and health protective measures for musicians as better than students not attending such courses already at the beginning of their first semester. This result suggests students being more aware of health threats for musicians are more willing to take courses on musicians' health early on in their education, which points to the need to address students in their first semester and raise their awareness regarding such topics. This has been also emphasized in a similar, 6 months follow-up study evaluating a health education program in beginner music students (Matei et al., 2018).

As a side note, health status and health behaviors at our university seem to have improved during the last 18 years. We distributed a similar questionnaire in 2002 to 340 bachelor and master students. The return rate was 62% ($n = 217$). Questions concerning playing-related pain location and pain frequency resulted in quite dramatic percentages: 40% of students reported constant (playing-related) shoulder pain and 37% reported constant playing-related back-pain. Since multiple responses were allowed, altogether more than 60% reported playing-related shoulder or back-pain (Gräser, 2004). Since this number is three times higher than in the present study, it may be indicative of an improvement of general health status and health behavior in our music students. However, it has to be taken into consideration that we used different wordings for the questionnaire and we included all bachelor and master students, not only first years. However, as a consequence of these results, we implemented a health program, specified in the introduction (Altenmüller, 2014). Furthermore, we regularly addressed health issues in public and private music schools and implemented regular training aiming to inform music teachers on "healthy music making" (Schuppert and Altenmüller, 2016).

Our study has several limitations that should be considered when interpreting the results. First, several measures were assessed with single items. Future studies should consider the aspects under investigation more comprehensively. Second, all results are based on participants' self-assessments and are, thus, subjective. Future studies should combine self-reported measures with objective observational data. Third, compared to music education majors, performance majors were underrepresented in the sample. This is probably due to the fact that our international students, who amount to about 60% of the performance majors, are frequently reluctant to fill in questionnaires in German or English language. In contrast, music education majors are mostly German-speaking (about 80%). Fourth, a possible selection bias should be considered since students participating in the survey might differ significantly from those who did not participate. Fifth, due to the data collection at only one music university and the small sample size, the generalizability of the results remains questionable. Sixth, the assessment of differences between students attending courses on musicians' health and those who did not were based on small groups and the assignment to one of the two groups was not randomized since the students could take such courses in their first two semesters at their own discretion. Finally, students were not surveyed after a full year at the university, but at the end of their second semester. Accordingly, the results at the second time point could be influenced by the potentially stressful phase at the end of a semester.

CONCLUSION AND PRACTICAL SUGGESTIONS FOR PROGRAMS ADDRESSING HEALTH ISSUES FOR MUSIC STUDENTS

Overall, our results provide some insights into the bodily and mental health status, health-related attitudes, behaviors, knowledge, and skills as well as coping strategies of music students at the beginning of their music university education in our specific institution. Generally, health status and health-related attitudes seem to have improved over the last decades, however, direct comparison to other studies remains difficult, since questionnaires applied and wordings of the questions differ in the above mentioned studies. Furthermore, health attitudes and well-being are dependent on many bio-psycho-social determinants, including music- and study-related factors, such as study organization, workload, minor subject, percentage

of international students, but also on bio-societal and socio-ecological factors including environment, nutrition behavior, work ethics etc. (for an overview concerning differences between music students and students from nursing or biomedical sciences see Ginsborg et al., 2009). Generally, an almost infinite number of biological (partially innate), socio-economic and other societal factors, many of them dynamically changing, determine health behaviors, which has been exemplified in adolescents' mental health in a recent review by Currie and Morgan (2020).

Further, this study offers some novel insights about the development of health-related aspects over the course of the first two semesters at a music university and the possible impact of courses on musicians' health, whereby selection bias may have influenced our results. Disappointingly, taking health-related courses does not improve music students' health, however, not astonishingly, informs students about health behaviors.

Five key points can be derived from the above:

1. Knowledge about music students' specific health challenges at the beginning of their university education can help music universities to better respond to the needs of their students and inform future measures to help music students maintain healthy over the course of their university education.
2. Generally, health status and knowledge about health-related behaviors in first-year music students are not satisfactory. Here, information and habit building needs to start earlier: in music schools and high schools. Peers and teachers have a pivotal role in the transmission of knowledge.
3. Music universities need to respond to the increasing challenges of cultural economy. Students have to be empowered to cope with the many stressors they will meet during their professional life. Therefore, it is extremely important, to draw music students' attention to health-related topics, to change their health-related attitudes, to raise awareness, and to teach them adequate measures to preserve good health. This seems especially important since professional musicians show poor health behaviors (Kenny et al., 2014).
4. Generally, this education – and even more important – habit formation should take place during the first year of study. This will raise awareness, prepare, and enable musicians later in their career to incorporate and engage in healthy behaviors.
5. Offering a comprehensive health program as we do is "nice-to-have" and students value it, however, future research should focus on appropriate measures to improve the transfer from the lecture hall to real life.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Joint Ethics Committee of the Leibniz University Hannover and the Hanover University of Music, Drama and Media (EV-LUH 9/2017). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MR designed and performed the study, evaluated the questionnaires, conducted the statistics, and wrote the manuscript. EB designed and performed the study, evaluated the questionnaires, and wrote the manuscript. EA designed the study, recruited the students, did the health program, evaluated the questionnaires, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

REFERENCES

Altenmüller, E. (2014). "Warum brauchen wir Musikphysiologie und Musikermedizin? Ein Thesenpapier," in *Klang, Körper und Gesundheit. Warum Musik für die Gesellschaft wichtig ist*. eds. E. Altenmüller and S. N. Willich (Augsburg: Wißner-Verlag), 47–58.

Altenmüller, E., and Jabusch, H. C. (2012). "Neurologie," in *MusikerMedizin. Diagnostik, Therapie und Prävention von musikerspezifischen Erkrankungen*. eds. C. Spahn, B. Richter and E. Altenmüller (Stuttgart: Schattauer), 188.

Antonini Philippe, R., Kosirnik, C., Vuichoud, N., Williamon, A., and Crettaz von Roten, F. (2019). Understanding well-being among college music students and amateur musicians in Western Switzerland. *Front. Psychol.* 10:820. doi: 10.3389/fpsyg.2019.00820

Araújo, L. S., Wasley, D., Perkins, R., Atkins, L., Redding, E., Ginsborg, J., et al. (2017). Fit to perform: an investigation of higher education music students' perceptions, attitudes, and behaviors toward health. *Front. Psychol.* 8:1558. doi: 10.3389/fpsyg.2017.01558

Árnason, K., Briem, K., and Árnason, Á. (2018). Effects of an education and prevention course for university music students on their body awareness and attitude toward health and prevention. *Med. Probl. Perform. Art.* 33, 131–136. doi: 10.21091/mppa.2018.2021

Barton, R., and Feinberg, J. R. (2008). Effectiveness of and educational program in health promotion and injury prevention for freshman musicmajors. *Med. Probl. Perform. Art.* 23, 47–53. doi: 10.21091/mppa.2008.2010

Beierlein, C., Kovaleva, A., Kemper, C., and Rammstedt, B. (2014). Eine Single-Item-Skala zur Erfassung von Risikobereitschaft: Die Kurzskala Risikobereitschaft-1 (R-1). GESIS Working Papers, 34.

Braden, A. M., Osborne, M. S., and Wilson, S. J. (2015). Psychological intervention reduces self-reported performance anxiety in high school music students. *Front. Psychol.* 6:195. doi: 10.3389/fpsyg.2015.00195

Brandfonbrener, A. G. (2009). History of playing-related pain in 330 university freshman music students. *Med. Probl. Perform. Art.* 24, 30–36. doi: 10.21091/mppa.2009.1007

Chesky, K. S., Dawson, W. J., and Manchester, R. (2006). Health promotion in schools of music: initial recommendations for schools of music. *Med. Probl. Perform. Art.* 21, 142–144. doi: 10.21091/mppa.2006.3027

Clark, T., Williamon, A., and Redding, E. (2013). The value of health screening in music schools and conservatoires. *Clin. Rheumatol.* 32, 497–500. doi: 10.1007/s10067-013-2203-9

Currie, C., and Morgan, A. (2020). A bio-ecological framing of evidence on the determinants of adolescent mental health – a scoping review of the

international health behaviour in school-aged children (HBSC) study 1983-2020. *SSM Popul Health* 12:100697. doi: 10.1016/j.ssmph.2020.100697

Dutta-Bergman, M. J. (2004). Health attitudes, health cognitions, and health behaviors among internet health information seekers: population-based survey. *J. Med. Internet Res.* 6:e15. doi: 10.2196/jmir.6.2.e15

Faul, F., Erdfelder, E., Lang, A.-G., and Buchner, A. (2007). G*power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* 39, 175–191. doi: 10.3758/BF03193146

Fry, H. J. H. (1987). Prevalence of overuse (injury) syndrome in Australian music schools. *Brit. J. Ind. Med.* 44, 35–40. doi: 10.1136/oem.44.1.35

Gembris, H., Heye, A., and Seifert, A. (2018). Health problems of orchestral musicians from a life-span perspective: results of a large-scale study. *Music Sci.* 1, 1–20. doi: 10.1177/2059204317739801

Gembris, H., Menze, J., Heye, A., and Bullerjahn, C. (2020). High-performing young musicians' playing-related pain. Results of a large-scale study. *Front. Psychol.* 11:564736. doi: 10.3389/fpsyg.2020.564736

Ginsborg, J., Kreutz, G., Thomas, M., and Williamon, A. (2009). Healthy behaviours in music and non-music performance students. *Health Educ.* 109, 242–258. doi: 10.1108/09654280910955575

Gräser, S. (2004). *Gesundheitsförderung für Musik-Studierende an der Hochschule für Musik und Theater Hannover: Eine Evaluation.* Oldenburg, Esbjerg: Universität Oldenburg, University of Southern Denmark.

Grieco, A., Occhipinti, E., Colombini, D., Menoni, O., Bulgheroni, M., Frigo, C., et al. (1989). Muscular effort and musculo-skeletal disorders in piano students: electromyographic, clinical and preventive aspects. *Ergonomics* 32, 697–716. doi: 10.1080/00140138908966837

Guptill, C., Zaza, C., and Stanely, P. (2000). An occupational study of physical playing-related injuries in college music students. *Med. Probl. Perform. Art.* 15, 86–90. doi: 10.21091/mppa.2000.2018

Hasselhorn, J., Hasselhorn, S., Altenmüller, E., and Hasselhorn, M. (2012). Performance anxiety among students of piano and voice. Does it change during duration of the studies? *Beiträge empirischer Musikpädagogik* 3, 2190–3174.

Hildebrandt, H., Nübling, M., and Candia, V. (2012). Increment of fatigue, depression, and stage fright during the first year of high-level education in music students. *Med. Probl. Perform. Art.* 27, 43–48. doi: 10.21091/mppa.2012.1008

Jørgensen, H. (2002). Instrumental performance expertise and amount of practice among instrumental students in a conservatoire. *Music. Educ. Res.* 4, 105–119. doi: 10.1080/14613800220119804

Kenny, D. T., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kreutz, G., Ginsborg, J., and Williamon, A. (2008). Music students' health problems and health-promoting behaviours. *Med. Probl. Perform. Art.* 23, 3–11. doi: 10.21091/mppa.2008.1002

Kreutz, G., Ginsborg, J., and Williamon, A. (2009). Health-promoting behaviours in conservatoire students. *Psychol. Music* 37, 47–60. doi: 10.1177/0305735607086047

Link, E., Baumann, E., and Klimmt, C. (2021). Explaining online information seeking behaviors in people with different health statuses: German representative cross-sectional survey. *J. Med. Internet Res.* 23:e25963. doi: 10.2196/25963

Lockwood, A. H. (1988). Medical problems in secondary school-aged musicians. *Med. Probl. Perform. Art.* 3, 129–132.

López, T. M., and Martínez, J. F. (2013). Strategies to promote health and prevent musculoskeletal injuries in students from the high conservatory of music of Salamanca, Spain. *Med. Prob. Perform Art* 28, 100–106. doi: 10.21091/mppa.2013.2018

Matei, R., Broad, S., Goldbart, J., and Ginsborg, J. (2018). Health education for musicians. *Front. Psychol.* 9:1137. doi: 10.3389/fpsyg.2018.01137

Matei, R., and Ginsborg, J. (2021). Health education for musicians in the UK: a qualitative evaluation. *Health Promot. Int.* 37:daab146. doi: 10.1093/heapro/daab146

Nawrocka, A., Mynarski, W., Powerska-Didkowska, A., Grabara, M., and Garbaciak, W. (2014). Musculoskeletal pain among polish music school students. *Med. Probl. Perform. Art.* 29, 64–69. doi: 10.21091/mppa.2014.2015

Panebianco-Warrens, C., Fletcher, L., and Kreutz, G. (2015). Health-promoting behaviors in south African music students: a replication study. *Psychol. Music* 43, 779–792. doi: 10.1177/0305735614535829

Perkins, R., Reid, H., Araújo, L. S., Clark, T., and Williamon, A. (2017). Perceived barriers and enablers to optimal health among music students: a qualitative study in the music conservatoire setting. *Front. Psychol.* 8:968. doi: 10.3389/fpsyg.2017.00968

Puls, H. (2004). Physioprophylaxe – ein Unterrichtsfach für Musikstudenten an der Hochschule für Musik "Hanns Eisler". *Musikphysiologie und Musikermedizin* 11, 5–12.

Rosset, M., Baumann, E., and Altenmüller, E. (2021). Studying music during the coronavirus pandemic: conditions of studying and health-related challenges. *Front. Psychol.* 12:651393. doi: 10.3389/fpsyg.2021.651393

Salamon, K. S., Hobart Davies, W., Fuentes, M. R., Weisman, S. J., and Hainsworth, K. R. (2014). The pain frequency-severity-duration scale as a measure of pain: preliminary validation in a pediatric chronic pain sample. *Pain Res. Manag.* 2014:653592. doi: 10.1155/2014/653592

Satow, L. (2012). Stress- und Coping-Inventar (SCI): Testmanual und Normen. Available at: http://www.drsatow.de (Accessed June 20, 2022).

Schneider, E., and Chesky, K. (2011). Social support and performance anxiety of college music students. *Med. Probl. Perform. Art.* 26, 157–163. doi: 10.21091/mppa.2011.3025

Schuppert, M., and Altenmüller, E. (2016). Musikermedizin in Deutschland: eine Standortbestimmung. *Musikphysiologie und Musikermedizin* 23, 109–125.

Spahn, C. (2006). *Gesundheit für Musiker – Entwicklung des Freiburger Präventionsmodells*. Bochum, Freiburg: Projectverlag.

Spahn, C. (2011). "Psychosomatische Medizin und Psychotherapie," in *MusikerMedizin. iagnostik, Therapie und Prävention von musikerspezifischen Erkrankungen*. eds. C. Spahn, B. Richter and E. Altenmüller (Stuttgart: Schattauer), 135–186.

Spahn, C., Hildebrandt, H., and Seidenglanz, K. (2001). Effectiveness of a prophylactic course to prevent playing-related health problems of music students. *Med. Probl. Perform. Art.* 16, 24–31. doi: 10.21091/mppa.2001.1005

Spahn, C., and Möller, H. (2011). "Psychosomatische Medizin und Psychotherapie," in *MusikerMedizin. Diagnostik, Therapie und Prävention von musikerspezifischen Erkrankungen*. eds. C. Spahn, B. Richter and E. Altenmüller (Stuttgart: Schattauer), 135–186.

Spahn, C., Nusseck, M., and Zander, M. (2014). Long-term analysis of health status and preventive behavior in music students across an entire university program. *Med. Probl. Perform. Art.* 29, 8–15. doi: 10.21091/mppa.2014.1003

Spahn, C., Strukely, S., and Lehmann, A. (2004). Health conditions, attitudes toward study, and attitudes toward health at the beginning of university study: music students in comparison with other student populations. *Med. Probl. Perform. Art.* 19, 26–33. doi: 10.21091/mppa.2004.1005

Steinmetz, A., Scheffer, I., Esmer, E., Delank, K. S., and Peroz, I. (2015). Frequency, severity and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany. *Clin. Rheumatol.* 34, 965–973. doi: 10.1007/s10067-013-2470-5

Tambs, K., and Røysamb, E. (2014). Selection of questions to short-form versions of original psychometric instruments in MoBa. *Norsk Epidemiologi* 24, 195–201. doi: 10.5324/nje.v24i1-2.1822

Williamon, A., Aufegger, L., and Eiholzer, H. (2014). Simulating and stimulating performance: introducing distributed simulation to enhance musical learning and performance. *Front. Psychol.* 5:25. doi: 10.3389/fpsyg.2014.00025

Williamon, A., and Thompson, S. (2006). Awareness and incidence of health problems among conservatoire students. *Psychol. Music* 34, 411–430. doi: 10.1177/0305735606067150

Wristen, B. G. (2013). Depression and anxiety in university music students. Update: applications of research in music. *Education* 31, 20–27. doi: 10.1177/8755123312473613

Zander, M. F., Voltmer, E., and Spahn, C. (2010). Health promotion and prevention in higher music education: results of a longitudinal study. *Med. Probl. Perform. Art.* 25, 54–65. doi: 10.21091/mppa.2010.2012

Zaza, C. (1992). Playing-related health problems at a Canadian music school. *Med. Probl. Perform. Art.* 7, 48–51.

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When nerves hit: The effect of trait anxiety, situational stress, and task mastery on the perception and interpersonal accuracy of musical expressiveness

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Music performance anxiety (MPA) is a prevalent phenomenon with potentially serious consequences to a musician's wellbeing and professional career. Yet, MPA does not always affect performance quality. It is hypothesized that trait anxiety, situational stress, and task mastery can exacerbate the effects of MPA and affect performance quality. Furthermore, it is unclear whether these effects are noticeable to both listeners and performing musicians. We measure performance quality as the expressiveness scores assigned by musicians and listeners to a set of pre-recorded performances. We selected three pianists with low, mid, and high MPA. Each pianist performed two pieces of their choice, familiar and unfamiliar, which were performed in rehearsal and recital conditions. The performances were videoed and edited into shorter clips for being presented to the performing pianists and to a set of online raters. Listeners and pianists will be asked to rate the expressiveness of all clips. We will determine the difference between the listeners' perceived expressiveness and the pianists' own expressiveness scores to estimate how well did listeners understand the pianists' expressive intentions. We investigate (1) what is the effect of trait anxiety, situational stress, and task mastery on the listener's perception of expressiveness and (2) what is the effect of these same variables on the listeners' understanding of expressiveness.

KEYWORDS

music performance anxiety, trait anxiety, situational stress, task mastery, interpersonal accuracy

1. Introduction

Music performance anxiety (MPA) is a prevalent phenomenon (Fernholz et al., 2019) among musicians, affecting them from early to post stages of a performance (Kenny, 2011; Chang-Arana et al., 2022). On its more severe manifestations, a musician may develop mood disorders (Kenny, 2011), choose to quit an otherwise promising career (Hernández et al., 2018; Fernholz et al., 2019), and engage in unhealthy strategies to cope with its debilitating symptoms such as drug consumption (Taylor and Wasley, 2004; West, 2004; Brugueìs, 2011a,b; Hernández et al., 2018). Kenny (2010) defines MPA as:

> The experience of marked and persistent anxious apprehension related to musical performance that has arisen through specific anxiety-conditioning experiences. It is manifested through combinations of affective, cognitive, somatic, and behavioral symptoms and may occur in a range of performance settings, but is usually more severe in settings involving high ego investment and evaluative threat. It may be focal (i.e., focused only on music performance), or occur comorbidly with other anxiety disorders, in particular social phobia. It affects musicians across the lifespan and is at least partially independent of years of training, practice, and level of musical accomplishment. It may or may not impair the quality of the musical performance (p. 433).

Despite the problems associated with MPA, it does not always affect performance quality (Kenny, 2011; Osborne et al., 2014). Under what circumstances can MPA affect performance? According to Wilson and Roland (2002) and others (Papageorgi et al., 2007; Matei and Ginsborg, 2017), there are three sources of stress in the context of music performance which can exacerbate the effects of MPA and affect performance quality: trait anxiety, situational stress, and task mastery.

Trait anxiety is "any personality characteristics, constitutional or learned, that mediate susceptibility to stress" (Wilson and Roland, 2002, p. 50). More specifically, Spielberger et al. (1983) defined it as the "differences between people in the tendency to perceive stressful situation as dangerous or threatening and to respond to such situations with elevations in the intensity of their state anxiety (S-Anxiety) reactions" (p. 5). A brief distinction between stress and anxiety is needed. While stress and anxiety share nearly identical symptoms, the former refers to emotional reactions in response to external triggers; while the latter refers to persistent emotional reactions even in the absence of such triggers (American Psychological Association, 2022). Some evidence suggests that trait anxiety and MPA are strongly correlated (e.g., Chang-Arana et al., 2018, reported an $r = 0.70$). That is, there is a large overlap between both concepts. Yet, while trait anxiety refers to overall tendencies to assess situations as threatening, MPA circumscribes the threat assessment to the musical context and takes into account the particularities and challenges specific to music performance.

Situational stress is "environmental pressures such as public performance, audition, or competition" (Wilson and Roland, 2002, p. 50). Similarly, Papageorgi et al. (2007) claimed that the "presence of an audience, the amount of perceived self-exposure and venue characteristics are considered to be significant variables" (p. 91). That is, MPA may manifest strongly in contexts where there is a sense of higher ego investment (Kenny, 2011). As we have reviewed earlier (Chang-Arana et al., 2022), past experimental studies in MPA suggest that musicians experience higher MPA (manifested through self-report and physiological manifestations) and lower performance quality scores when performing in front of an audience vs. when playing alone (Brotons, 1994; LeBlanc et al., 1997; Yoshie et al., 2008, 2009; Wells et al., 2012; Kwan, 2016). Although in our previous work (Chang-Arana et al., 2022) we did not find an effect of performance context on the listener's perception of MPA.

Task mastery ranges "from performances of simple, well-rehearsed works to those of complex, unprepared material" (Wilson and Roland, 2002, p. 50). Studies indicate that tertiary music students (Kenny et al., 2011; Casanova et al., 2018), as well as professional musicians (Roland, 1994; Kenny et al., 2012; Biasutti and Concina, 2014) report inadequate preparation for a performance as a cause for experiencing MPA. Conversely, higher self-efficacy in tertiary music students relates to less self-reported performance anxiety (Zarza-Alzugaray et al., 2016a). Yet, to the best of our knowledge no experimental studies in MPA have tested the effect of unprepared performances on the musician's experience of anxiety and the listener's perception of performance quality.

One indicator of performance quality is musical expressiveness (Thompson and Williamon, 2003; Wapnick et al., 2004; Kwan, 2016). Musical expressiveness has been defined as "those aspects of a musical performance that are under the control of the performer, and which the performer manipulates for aesthetic and communicative purposes. These may be considered aspects of musical prosody (Bernstein, 1976/1981)" (Bhatara et al., 2011, p. 921). Acoustically, expressiveness is a complex construct associated with variations in timing, dynamics, timbre, articulation, and intonation occurring during the interpretation of a piece (Davidson, 1993; Broughton and Stevens, 2009; Thompson and Luck, 2012; Vuoskoski et al., 2014).

Some studies have investigated how the listener's perception of different performance quality metrics, including expressiveness, change according to the listener's musical background (Stanley et al., 2002; Wapnick et al., 2004; Thompson, 2006; Geringer and Johnson, 2007;

Johnson and Geringer, 2007; Broughton and Stevens, 2009; Broughton and Davidson, 2014). Musicians can detect differences in performance quality of ensembles of different musical level (Geringer and Johnson, 2007; Johnson and Geringer, 2007). The skills to discriminate performance quality may also depend on the listener's main instrument (Wapnick et al., 2004; Broughton and Davidson, 2014). Kwan (2016) reported differences in the listener's perception of expressiveness and performance quality, depending on their musical background. Our own research (Chang-Arana et al., 2022) suggests that musicians perceive more anxiety in a technically challenging piece when compared to non-musicians.

Musicians aim at communicating their expressive intentions to the listeners (Spiro and Schober, 2021) and endure uncountable hours of practice, as well as emotional, physical, and professional pressures to do so (Czerwiński et al., 2022). Yet, rarely do we know whether listeners are capable of perceiving accurately the performer's expressive intentions. Such a comparison would allow evaluating the effectiveness of communication between musicians and listeners, providing musicians with a source of information of what listeners understand from the performances they listen to.

The concept of interpersonal accuracy allows investigating whether listeners perceive accurately the musician's expressive intentions. Interpersonal accuracy is the "accurate judgment about any verifiable characteristic of a person or about the group that a person belongs to" (Hall et al., 2016, p. 5). The notion of accuracy is always abstract and context-dependent; thus, it is necessary to operationalize what constitutes an accurate judgment in a specific research context (Hall et al., 2016). In the context of this study, the listeners' interpersonal accuracy is defined as the difference between the listener's perception of expressiveness and the pianist's self-reported expressiveness; the lower the difference, the higher the listener's interpersonal accuracy (Chang-Arana et al., 2022).

Someone's interpersonal accuracy (IA) is influenced by different contextual factors (Schmid, 2016). These can be as diverse as belonging to a particular socioeconomic status (Bänziger et al., 2011; Bjornsdottir et al., 2017), adopting similar body postures with the interacting partner (Fujiwara and Daibo, 2022), and even being in a violent relationship (Clements et al., 2007). The experience from previous studies suggests that the listeners' skills to accurately infer the expressive intentions of a performer may be influenced by different factors. In this study, we explore two potential sources of influences. The first are the three sources of stress in the context of music performance which can affect performance quality (i.e., trait anxiety, situational stress, and task mastery). The second is the listeners' musical background.

Given these antecedents, we investigate two research questions (RQs):

> RQ1: What is the effect of MPA, situational stress, and task mastery on the listener's perception of expressiveness, while considering their musical background?

> Hypothesis 1: There will be differences in perceived expressiveness of the musicians depending on their MPA, situational stress, and task mastery (Wilson and Roland, 2002), when considering the listeners' musical background.

> RQ2: What is the effect of MPA, situational stress, and task mastery on the listener's interpersonal accuracy, while considering their musical background?

> Hypothesis 2: There will be differences in the listeners' interpersonal accuracy of expressiveness depending on the musician's MPA, situational stress, and task mastery, when considering the listeners' musical background (Chang-Arana et al., 2022).

2. Methods

2.1. Ethical approval

This study was approved by Aalto University Research Ethics Committee and the University of Arts Helsinki – Sibelius Academy.

2.2. Stimuli creation procedure

Ten pianists from a leading tertiary music institution in Finland took part in the study (mean age = 23, *SD* = 2.31). The pianists were compensated with 2 credit points, 100 euros (€), and recordings of their performances. They were assured to be compensated even if they would prefer not to share their musical performances after the recitals and withdraw their recordings. We chose pianists because solo instrumentalists may show more MPA than orchestral instrumentalists, particularly as they approach the end of their studies (Casanova et al., 2018; Chang-Arana et al., 2022).

Pianists were initially informed that the purpose of the study was to investigate how the COVID pandemic impacted interactions between musicians and audiences. Since this was a MPA study, it was important not to reveal the true goal of the study. The pianists were contacted 7 weeks before the

performing days. They were asked to prepare a programme of two pieces which had to be memorized: one familiar and another one unfamiliar. We defined the familiar piece as one which "you have played it for an audience before," whereas the unfamiliar piece as "a piece new to you which you have never played for yourself or for anybody else." After the initial meeting, they completed sociodemographic questionnaires as well as the Revised Kenny-Music Performance Anxiety Inventory (K-MPAI, Kenny, 2009), and other questionnaires not reported here. To control for familiarity with the piece, we only allowed the pianists to start practicing them 3 weeks before the performances, using the cover story that the criteria to choose the unfamiliar piece was still undecided. We instructed the pianists to "choose a piece which you have never played even for yourself and which you think you can get memorized for May's recital. Remember that this piece should match your current performing level." To keep a track of their performance practice, we asked the pianists to fill in an online performance diary every time they had a practice session.

Two online recitals were organized and advertised through social media and from mouth-to-mouth 3 days before the first performing day. The pianists were randomly assigned to either day, as well as the order on which they would perform their chosen pieces. The performances took place in the same hall using a Steinway & Sons model C grand piano. The pianists performed their programme twice during their assigned day, first the rehearsal condition and then the online-streaming condition. We chose this order because in real circumstances musicians will have a dress-rehearsal session prior to the actual performance. Here we decided to reproduce that context even though a learning effect could have been introduced. The pianists were instructed to wear the same cloths for both performances. Before starting the rehearsal condition, the pianists were allowed to warm up, complete the State subscale of the State-Trait Anxiety Inventory (STAI, Spielberger et al., 1983), and do a sound check. The State subscale was administered to measure their anxiety before the rehearsal. The pianists were then read the following instructions by Kwan (2016, p. 22):

> "You will have 60 min to play your music as many times as you want to until you feel satisfied with the performance, and you can restart the piece at any moment you want, as long as there is a completed performance by the end of the session. You are allowed to take breaks and evaluate your own recordings between performances."

During the concert condition, the pianists arrived 30 min before the beginning of the concert and completed the State-STAI once again to measure their anxiety before the online performance. They waited on the hallway and came to play one at the time. The only difference from the rehearsal condition was a phone streaming the performance and a laptop connected to Zoom which displayed the audience's profiles to the pianists. The first author was present with them in both performing conditions.

Each pianist completed a self-rating task based on their own performances. They watched back to approx. 1 min clips of their rehearsal and concert performances and rated each of them according to their expressiveness (Kendall and Carterette, 1990, p. 156; Kwan, 2016) using a 1–100 continuous scale (Chang-Arana et al., 2022):

- How expressive was the rendition of this piece? Musical expression can be likened to the expression of an actor in speaking their part: They may speak in a monotone, in a manner appropriate to the idea, or they might exaggerate.

Then, the pianists were fully debriefed about the objectives of the study as well as the full details of the study design and procedure. During the debriefing we corroborated that none of the pianists guessed that MPA was the real object of study. The clips belonging to pianists with the lowest, middle, and highest scores in the K-MPAI were chosen for the perceptual study (i.e., pianist 1, 5, and 10).

As in Chang-Arana et al. (2022), we will recruit professional pianists with extensive piano performance and teaching experience to watch all clips in counterbalanced order. Using a 10-point Likert scale, the pianists will rate how much did the observed pianists move after watching each clip. The inter-rater reliability of the judges will be calculated through intraclass correlation (ICC, Koo and Mae, 2016).

2.3. Questionnaires and materials

2.3.1. Music performance anxiety

The K-MPAI (Kenny, 2009) is a 40-item self-report scale. It was designed by Kenny (2009) after Barlow's (2000) triple vulnerability model. It explains the origin of anxiety disorders as a consequence of an interaction between three vulnerabilities: biological (hereditary anxiety components), psychological (early experiences resulting in a sense of uncontrollability), and specific life conditioning events. The questionnaire has been translated to different languages such as Portuguese (Rocha et al., 2011; Barbar et al., 2014a,b,c, 2015), Spanish (Zarza-Alzugaray et al., 2016b; Chang-Arana et al., 2018), Romanian (Faur et al., 2021), among others. Furthermore, its psychometric properties have been tested cross-culturally (Chang-Arana et al., 2018). The K-MPAI has shown a strong correlation of $r = 0.70$ with trait anxiety (Chang-Arana et al., 2018).

2.3.2. State-trait anxiety

The STAI (Spielberger et al., 1983) is a 40-items self-report scale. The state and trait subscales contain 20 items each to be rated on a 4-points Likert scale. The

internal consistency of the scale ranges from 0.86 to 0.95 (American Psychological Association, 2011), both values above the Nunnally (1987) criterion of 0.70.

2.3.3. Perceived expressiveness

This scale is designed based on Kwan (2016) and defined according to Kendall and Carterette (1990).

2.3.4. Recording equipment

Performances were recorded using Rode NT5 Condenser microphones, a MOTU Ultralite mk4 USB Audio Interface, and a Sony HDR-CV560VE Camcorder.

2.4. Perceptual study procedure

One hundred twenty online participants will be recruited using Prolific (Peer et al., 2017), and social media to complete the study. The instructions and tasks will be based on Chang-Arana et al. (2022): Participants will be presented with approximately 1 min clips of each piece (familiar and unfamiliar), performed on both conditions (rehearsal and recital). Clips were edited and the pianists' faces blurred using Shotcut (Meltytech). Each piece performed in rehearsal and recital condition will be grouped together and presented in random order. After each clip, participants will rate the pianists' expressiveness as defined in Section "Stimuli creation procedure." Participants will be asked to self-identify as non-musicians or music-loving non-musician (<6 years of private lessons and <6 years of daily practice and not enrolled in a college music course), amateur or serious amateur musicians (between 6 and 10 years of private lessons and >6 years of daily practice and enrolled in 1–2 non-major music courses), or semi-/professional musicians (>10 years of private lessons and >6 years of daily practice and enrolled in a Bachelor of Music degree), with the question "which title best describes you?" (Zhang and Schubert, 2019). The study was implemented online in Gorilla platform (Anwyl-Irvine et al., 2020).

2.5. Data analysis

To answer RQ1, we will conduct a 2 (rehearsal vs. recital) × 2 (familiar vs. unfamiliar) × 3 (low MPA vs. mid MPA vs. high MPA) mixed repeated-measures ANOVA, with musical background (non-musicians vs. amateur musicians vs. semi/professional musicians) as between-subjects variable, and the listeners' perceived expressiveness scores as dependent variable. To answer RQ2, we will conduct the same analyses, only that the dependent variable will be the listeners' interpersonal accuracy of expressiveness. For RQ1 and RQ2, we will set our p-value to 0.025 (0.05/2 tests conducted with the same data) (Field, 2009). Interpersonal accuracy is defined as the pianist's self-reported expressiveness on a given clip minus the listener's perceived expressiveness on the same clip. Our *a priori* repeated measures, within-between interaction calculation of sample size suggests 108 participants, given an effect size $f = 0.10$, $\alpha = 0.025$, $1\text{-}\beta = 0.80$, number of groups = 3, number of measurements = 12, correlation among repeated measures = 0.50, and non-sphericity correction $\varepsilon = 1$ (Faul et al., 2007). Each level of our between-subjects variables will have the same number of participants. We will add equally to each group at least 10% more participants to account for missing values or data points which could be eliminated for justified reasons (e.g., outliers, participants not answering diligently, etc.). Thus, each group will have at least 40 participants.

3. Preliminary results

The K-MPAI, Trait-STAI, and State-STAI scores are displayed in **Table 1**. **Table 1** reveals two interesting results. The K-MPAI and Trait-STAI values showed a significant and strong correlation, $r = 0.75$, $p = 0.013$, 95% CI (0.22, 0.94). The strong correlation between the K-MPAI and the Trait-STAI supports (a) our decision to use the scores of the K-MPAI as a measure of trait anxiety and (b) our reasoning to choose pianists 1, 5, and 10. Second, the difference in state anxiety experienced by the pianists before the rehearsal ($M = 37.40$, $SD = 5.99$) and recital conditions ($M = 38.10$, $SD = 9.17$) was not significantly different, even though we would have expected to see higher scores in the recital condition, $t(9) = -0.44$, one-sided $p = 0.336$, 95% CI (−4.32, 2.92). Based solely on the state anxiety scores, listeners may not be able to perceive differences in expressiveness according to performing context.

On average, the pianists self-rated their performances during the rehearsal condition as more expressive than in the rehearsal condition (see **Table 2** for further details). When performing the familiar pieces in the rehearsal condition ($M = 79.00$, $SD = 12.67$), pianists self-reported more expressiveness than when performing the familiar pieces in the recital condition ($M = 75.00$, $SD = 14.70$). Similarly, pianists self-reported more expressiveness when performing the unfamiliar pieces in the rehearsal condition ($M = 76.70$, $SD = 8.95$) than in the recital condition ($M = 70.10$, $SD = 16.05$). Furthermore, the expressiveness scores showed higher variability for the unfamiliar pieces ($SD = 13.72$) than for the familiar pieces ($SD = 11.45$).

Next, we focus further into the three pianists chosen for the perceptual study. Following the same procedure described in Chang-Arana et al. (2022), we extracted four acoustic features (duration, tempo, pulse clarity, and intensity) from the

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TABLE 1 Pianists' kenny-music performance anxiety inventory (K-MPAI) and STAI scores.

Pianist	K-MPAI	Trait-STAI	State-STAI		
			Rehearsal	Recital	Difference
1	44	29	37	38	−1
2	44	36	38	28	10
3	60	43	39	40	−1
4	91	48	43	50	−7
5	94	51	36	31	5
6	105	48	37	41	−4
7	106	54	23	22	1
8	107	38	39	43	−4
9	135	52	46	51	−5
10	144	50	36	37	−1

TABLE 2 Difference in pianist's self-reported expressiveness, according to task mastery and situational stress.

Pianist	Familiar piece			Unfamiliar piece		
	Rehearsal	Recital	Expressiveness difference	Rehearsal	Recital	Expressiveness difference
1	95	91	4	85	76	9
2	100	90	10	90	100	−10
3	77	82	−5	65	62	3
4	67	45	22	70	70	0
5	65	60	5	80	65	15
6	81	75	6	86	60	26
7	70	90	−20	78	95	−17
8	90	75	15	75	65	10
9	80	75	5	75	50	25
10	65	67	−2	63	58	5

TABLE 3 Extracted musical features of pieces performed.

Pianist			Duration (seconds)	Tempo (bpm)	Pulse clarity	Attack leap
1 (Low MPA)	Familiar	Practice	73.24	80.76	0.17	0.12
		Recital	71.29	104.42	0.15	0.15
	Unfamiliar	Practice	63.48	101.60	0.15	0.11
		Recital	64.67	87.28	0.16	0.12
5 (Middle MPA)	Familiar	Practice	77.11	121.39	0.22	0.12
		Recital	76.12	121.00	0.19	0.12
	Unfamiliar	Practice	63.88	136.98	0.27	0.23
		Recital	61.00	138.56	0.25	0.23
10 (High MPA)	Familiar	Practice	98.55	83.76	0.20	0.31
		Recital	97.45	98.26	0.19	0.31
	Unfamiliar	Practice	60.19	146.61	0.22	0.27
		Recital	56.17	151.42	0.20	0.22

recorded pieces using the MATLAB (2021) based MIRtoolbox (Lartillot and Toiviainen, 2007): Duration, tempo, pulse clarity, and intensity (attack leap) (**Table 3**). Duration was estimated in seconds by dividing the "total samples of each excerpt with the sampling rate (44 kHz)" (Chang-Arana et al., 2022, p. 5). Tempo was obtained with *mirtempo* function (Lartillot, 2021), pulse clarity was detected using the *mirpulseclarity* function (Lartillot et al., 2008), and intensity was calculated using the *mirattackleap* function (Lartillot, 2021). All three pianists played their familiar pieces faster in the recital condition. Regarding the unfamiliar pieces, only Pianist 1 played their selected piece slower. Pianist 10 showed the highest increase in tempo (and less duration) of their selected unfamiliar piece. See **Table 3**. Next, we present preliminary results with a sample of 30 participants (professional/semi-professional musicians = 10, amateur musicians = 10, non-musicians = 10).

3.1. RQ1: What is the effect of MPA, situational stress, and task mastery on the listener's perception of expressiveness, while considering their musical background?

Mauchly's test suggests that the assumption of sphericity has been met for the MPA levels, $\chi^2(2) = 4.74$, $p = 0.094$. A significant effect of MPA levels on the perception of expressiveness was observed, $F(2, 54) = 30.74$, $p < 0.001$, $\eta_p^2 = 0.53$. The pianist with the lowest self-reported MPA [$M = 75.69$, $SE = 1.89$, 97.5% CI (71.20, 80.19)] was rated with the highest expressiveness scores, followed by the pianist with the highest self-reported MPA [$M = 66.75$, $SE = 2.66$, 97.5% CI (60.44, 73.06)], and lastly the pianist with the mid self-reported MPA [$M = 56.61$, $SE = 2.76$, 97.5% CI (50.05, 63.16)].

There was a significant effect of familiarity on the perception of expressiveness, $F(1, 27) = 24.95$, $p < 0.001$, $\eta_p^2 = 0.48$. Listeners rated the familiar pieces as more expressive [$M = 70.93$, $SE = 2.12$, 97.5% CI (65.90, 75.96)] than the unfamiliar pieces [$M = 61.77$, $SE = 2.33$, 97.5% CI (56.25, 67.30)].

Furthermore, a significant interaction between self-reported MPA and familiarity with the piece was observed (**Figure 1**), $F(2, 54) = 14.08$, $p < 0.001$, $\eta_p^2 = 0.34$. When rating the pianist with the lowest MPA, the unfamiliar piece [$M = 69.70$, $SE = 2.50$, 97.5% CI (63.77, 75.63)] was perceived as less expressive than the familiar piece [$M = 81.68$, $SE = 2.55$, 97.5% CI (75.63, 87.74)]. When rating the pianist with mid MPA, the unfamiliar piece [$M = 58.62$, $SE = 2.69$, 97.5% CI (52.23, 65.00)] was perceived as more expressive than the familiar piece [$M = 54.60$, $SE = 3.41$, 97.5% CI (46.51, 62.69)]. When rating the pianist with high MPA, the unfamiliar piece [$M = 57.00$, $SE = 3.70$, 97.5% CI (48.22, 65.78)] was perceived as less expressive than the familiar piece [$M = 76.50$, $SE = 2.56$, 97.5% CI (70.43, 82.57)].

3.2. RQ2: What is the effect of MPA, situational stress, and task mastery on the listener's interpersonal accuracy, while considering their musical background?

In **Table 4**, we present a summary of the listeners' mean perceived expressiveness and the pianists' self-reported expressiveness. In 9 out of 12 videos, we observe a negative difference. This indicates that, across stimuli, the listeners perceived less expressiveness than what the pianists self-reported.

Following a past procedure (Chang-Arana et al., 2022, p. 7), we calculated the difference between the listeners' perceived expressiveness scores and the pianists' self-reported expressiveness. This difference was squared and then squared rooted to transform the scores into positive values. Values closer to 0 indicate higher accuracy. Conversely, values larger than 0 indicate lower accuracy.

A significant effect of performance context on the listeners' accurate inference of expressiveness was observed, $F(1, 27) = 11.83$, $p = 0.002$, $\eta_p^2 = 0.31$. Listeners were more accurate when inferring the pianists' self-reported expressiveness when rating the recital condition [$M = 14.07$, $SE = 1.00$, 97.5% CI (11.70, 16.44)] than when rating the rehearsal condition [$M = 18.54$, $SE = 1.32$, 97.5% CI (15.41, 21.68)].

4. Preliminary discussion

The pianists' data suggests that they experienced approximately the same state anxiety before the rehearsal and before the recital. Thus, our expectation of observing higher state anxiety scores in the recital condition when compared to the rehearsal condition was not met.

Yet, it was interesting to observe that the pianists rated their rehearsal performances as more expressive than the recital performances, independently of the familiarity with the piece. In addition, we observed that the pianists with the lowest, middle, and highest MPA performed at a faster tempo in the recital when compared to the rehearsal, independently of the familiarity with the piece (except for the pianist with the lowest trait anxiety who played their unfamiliar piece slower). Taking the observed differences of expressiveness and tempo together, the manipulation of anxiety may have had an effect undetected by the State-STAI. In a previous study, we documented increases in tempo when performing in a recital condition in comparison to a rehearsal condition

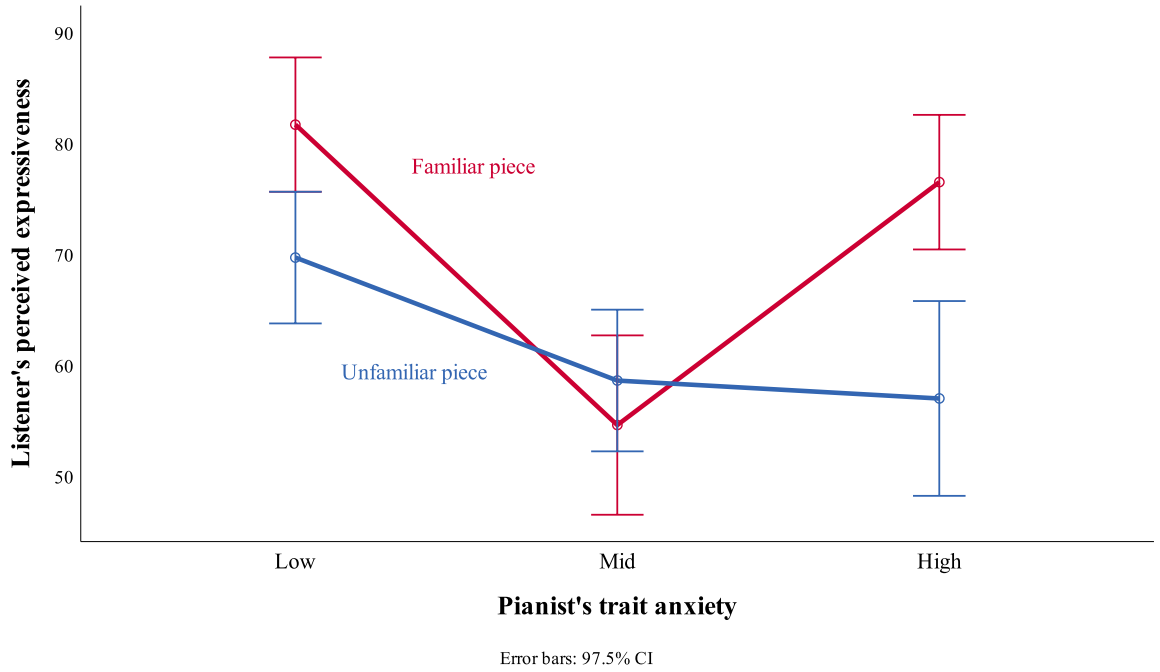

FIGURE 1
Interaction between self-reported music performance anxiety (MPA) and familiarity with the piece.

TABLE 4 Listeners' mean perceived expressiveness and pianists' self-reported expressiveness.

Trait anxiety	Familiarity and performance condition	Listeners' mean perceived expressiveness	Pianist's self-rated expressiveness	Difference
Low	Familiar rehearsal	82.00	95.00	13.00
	Familiar recital	81.37	91.00	−9.63
	Unfamiliar rehearsal	69.93	85.00	−15.07
	Unfamiliar recital	69.47	76.00	−6.53
Mid	Familiar rehearsal	53.40	80.00	−26.60
	Familiar recital	55.80	65.00	−9.20
	Unfamiliar rehearsal	58.87	65.00	−6.13
	Unfamiliar recital	58.37	60.00	−1.63
High	Familiar rehearsal	76.60	65.00	11.60
	Familiar recital	76.40	67.00	9.40
	Unfamiliar rehearsal	57.93	63.00	−5.07
	Unfamiliar recital	56.07	58.00	−1.93

(Chang-Arana et al., 2022). We drew a parallel of these results to fast speech during public speaking observed in individuals with panic disorder and social phobia (Hagenaars and van Minnen, 2005; Laukka et al., 2008; Chang-Arana et al., 2022).

Preliminary results suggest that the performances of the pianists with the lowest and highest self-reported MPA obtained the highest perceived expressiveness scores, while the pianist with the mid self-report MPA received the lowest perceived expressiveness scores. Although it is soon to confirm this trend, it could be explained by the body movements displayed by the pianists. To control for the known effects of ancillary gestures in the listeners' heightened perception of expressiveness (Davidson, 1993; Vuoskoski et al., 2014), a group of professional pianists will rate the performers' body movements (Chang-Arana et al., 2022).

Regardless of the listener's musical background, they perceived the familiar pieces as more expressive than the

unfamiliar pieces. Previous literature has linked inadequate preparation and low self-efficacy of musicians to experiencing higher MPA (Roland, 1994; Kenny et al., 2011, 2012; Biasutti and Concina, 2014; Zarza-Alzugaray et al., 2016a; Casanova et al., 2018). If our future analysis supports our preliminary results, then differences on the preparation for a performance are noticeable to listeners with varied musical experience too.

Preliminary results seem to indicate that the listeners' inference of expressiveness was more accurate in the recital condition in comparison to the rehearsal condition. Yet, this is not explained by the listener's IA skills, rather by the pianists' expressiveness scores approaching the listener's scores. Pianists reported less expressiveness in the recital conditions in contrast to the rehearsal condition. **Table 3** shows that the listeners' mean perceived expressiveness is similar between performing contexts. Thus, the difference in IA can be attributed to the pianists' self-rating scores, rather than the listener's IA skills.

In sum, this study investigates the effect of musicians' MPA, situational stress, and task mastery on the listeners' perception of expressiveness and interpersonal accuracy, while considering their musical background. We investigate this through an experimental manipulation where pianists with the lowest, mid, and highest self-reported MPA performed a familiar and an unfamiliar piece in front of an online audience and in absence of an audience. Listeners will be asked to rate the expressiveness of these performances, being blind to the experimental manipulations. The listeners' IA will be calculated as is the difference between their perceived expressiveness and the pianists' self-reported expressiveness.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors while complying with GDPR regulations.

Ethics statement

The studies involving human participants were reviewed and approved by Aalto University Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ÁC-A designed the study and wrote the manuscript. AM developed the coding and conducted the music information retrieval analyses. NP enabled contacting the pianists who participated, as well as using the facilities of the music institution. MT provided general supervision of the study. All authors contributed substantially in the writing and preparation of the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

American Psychological Association, (2011). *The State-Trait Anxiety Inventory (STAI)*. Available online at: https://www.apa.org/pi/about/publications/caregivers/practice-settings/assessment/tools/trait-state (accessed December 22, 2022).

American Psychological Association (2022). *What's the Difference Between Stress and Anxiety?*. Available online at: https://www.apa.org/topics/stress/anxiety-difference (accessed December 22, 2022).

Anwyl-Irvine, A. L., Massonieì, J., Flitton, A., Kirkham, N. Z., and Evershed, J. K. (2020). Gorilla in our midst: an online behavioural experiment builder. *Behav. Res. Methods* 52, 388–407. doi: 10.3758/s13428-019-01237-x

Bänziger, T., Scherer, K. R., Hall, J. A., and Rosenthal, R. (2011). Introducing the MiniPONS: a short multichannel version of the profile of nonverbal sensitivity (PONS). *J. Nonverb. Behav.* 35, 189–204. doi: 10.1007/s10919-011-0108-3

Barbar, A. E., Crippa, J. A., and Osoìrio, F. L. (2014a). Kenny Music Performance Anxiety Inventory (KMPAI): transcultural adaptation for Brazil and study of internal consistency. *J. Depress. Anxiety* 3:167. doi: 10.21091/mppa.2021.3020

Barbar, A. E., Crippa, J. A., and Osoìrio, F. L. (2014b). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 152–154, 381–386. doi: 10.1016/j.jad.2013.09.041

Barbar, A. E., Crippa, J. A., and Osoìrio, F. L. (2014c). Parameters for screening music performance anxiety. *Rev. Brasil. Psiquiatria* 36, 245–247.

Barbar, A. E., Souza, J. A., and Osoìrio, F. L. (2015). Exploratory factor analysis of Kenny music performance anxiety inventory (K-MPAI) in a Brazilian musician sample. *Arch. Clin. Psychiatry* 42, 113–116.

Barlow, D. (2000). Unraveling the mysteries of anxiety and its disorders from the perspective of emotion theory. *Am. Psychol.* 55, 1247–1263. doi: 10.1037//0003-066x.55.11.1247

Bernstein, L. (1976/1981). *The unanswered questions: Six talks at Harvard (The Charles Eliot Norton Lectures)*. Cambridge, MA: Harvard University Press.

Bhatara, A., Tirovolas, A. K., Duan, L. M., Levy, B., and Levitin, D. J. (2011). Perception of emotional expression in musical performance. *J. Exp. Psychol.* 37, 921–934. doi: 10.1037/a0021922

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Musicae Sci.* 18, 189–202. doi: 10.1177/1029864914523282

Bjornsdottir, R. T., Alaei, R., and Rule, N. O. (2017). The perceptive proletarian: subjective social class predicts interpersonal accuracy. *J. Nonverb. Behav.* 41, 185–201. doi: 10.1007/s10919-016-0248-6

Brotons, M. (1994). Effects of performing conditions on music performance anxiety and performance quality. *J. Music. Ther.* 31, 63–81.

Broughton, M. C., and Davidson, J. W. (2014). Action and familiarity effects on self and other expert musician's Laban effort-shape analyses of expressive bodily behaviors instrumental music performance: a case study. *Front. Psychol.* 5:1201. doi: 10.3389/fpsyg.2014.01201

Broughton, M. C., and Stevens, C. (2009). Music, movement and marimba: an investigation of the role of movement and gesture in communicating musical expression to an audience. *Psychol. Music* 37, 137–153. doi: 10.1177/0305735608094511

Brugueìs, A. O. (2011a). Music performance anxiety—part 1: a review of its epidemiology. *Med. Probl. Perform. Art* 26, 102–105. doi: 10.21091/mppa.2011.2015

Brugueìs, A. O. (2011b). Music performance anxiety—part 2: a review of treatment options. *Med. Probl. Perform. Art* 26, 164–171. doi: 10.21091/mppa.2011.3026

Casanova, O., Zarza-Alzugaray, F. J., and Orejudo, S. (2018). Differences in performance anxiety levels among advanced conservatory students in Spain, according to type of instrument and academic year of enrolment. *Music Educ. Res.* 20, 377–389. doi: 10.1080/14613808.2018.1433145

Chang-Arana, ÁM., Kenny, D. T., and Burga-León, A. A. (2018). Validation of the Kenny music performance anxiety inventory (K-MPAI): a cross-cultural confirmation of its factorial structure. *Psychol. Music* 46, 551–567. doi: 10.1177/0305735617717618

Chang-Arana, ÁM., Mavrolampados, A., Thompson, M. R., Pokki, N., and Sams, M. (2022). Exploring the interpersonal level of music performance anxiety: online listener's perception and accurate inference of anxiety. *Front. Psychol.* 13:838041. doi: 10.3389/fpsyg.2022.838041

Clements, K., Holtzworth-Munroe, A., Schweinle, W., and Ickes, W. (2007). Empathic accuracy of intimate partners in violent versus nonviolent relationships. *Pers. Relatsh.* 14, 369–388. doi: 10.1111/j.1475-6811.2007.00161.x

Czerwiński, S. K., Lawendowski, R., Kierzkowski, M., and Atroszko, P. A. (2022). Can perseverance of effort become maladaptive? Study addiction moderates the relationship between this component of grit and well-being among music academy students. *Musicae Sci.* doi: 10.1177/10298649221095135 [Epub ahead of print].

Davidson, J. W. (1993). Visual perception of performance manner in the movements of solo musicians. *Psychol. Music* 21, 103–113. doi: 10.1177/030573569302100201

Faul, F., Erdfelder, E., Lang, A.-G., and Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* 39, 175–191.

Faur, A. L., Vaida, S., and Opre, A. (2021). Kenny music performance anxiety inventory: exploratory factor analysis of the Romanian version. *Psychol. Music* 49, 777–788. doi: 10.1177/0305735619896412

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: A systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/S0033291719001910

Field, A. (2009). *Discovering Statistics Using SPSS*, 3rd Edn. Thousand Oaks, CA: Sage.

Fujiwara, K., and Daibo, I. (2022). Empathic accuracy and interpersonal coordination: behavior matching can enhance accuracy but interactional synchrony may not. *J. Soc. Psychol.* 162, 71–88. doi: 10.1080/00224545.2021.1983509

Geringer, J. M., and Johnson, C. M. (2007). Effects of excerpt duration, tempo, and performance level on musicians' ratings of wind band performances. *J. Res. Music. Educ.* 55, 289–301. doi: 10.1177/0022429408317366

Hagenaars, M. A., and van Minnen, A. (2005). The effect of fear on paralinguistic aspects of speech in patients with panic disorder with agoraphobia. *Anxiety Disord.* 19, 521–537. doi: 10.1016/j.janxdis.2004.04.008

Hall, J. A., Mast, M. S., and West, T. V. (2016). "Accurate interpersonal perception: many traditions, one topic," in *The Social Psychology of Perceiving Others Accurately*, eds J. A. Hall, M. S. Mast, and T. V. West (Cambridge, MA: Cambridge University Press), 3–22.

Hernández, S. O., Zarza-Alzugaray, F. J., and Casanova, O. (2018). Music performance anxiety. Substance use and career abandonment in Spanish music students. *Int. J. Music. Educ.* 36, 460–472. doi: 10.1177/0255761418763903

Johnson, C. M., and Geringer, J. M. (2007). Predicting music majors' overall ratings of wind band performances: elements of music. *Bull. Counc. Res. Music. Educ.* 173, 25–38.

Kendall, R. A., and Carterette, E. C. (1990). The Communication of Musical Expression. *Music Percept.* 8, 129–163. doi: 10.2307/40285493

Kenny, D. T. (2009). "The factor structure of the revised kenny music performance anxiety inventory," in *Proceedings of the International Symposium on Performance Science*, Auckland.

Kenny, D. T. (2010). "The role of negative emotions in performance anxiety," in *Handbook of Music and Emotion: Theory, Research, and Applications*, eds P. N. Juslin and J. A. Sloboda (London: Oxford University Press), 425–452.

Kenny, D. T. (2011). *The Psychology of Music Performance Anxiety*. New York, NY: Oxford University Press.

Kenny, D. T., Driscoll, T., and Ackermann, B. (2012). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T., Fortune, J. M., and Ackermann, B. (2011). Predictors of music performance anxiety during skilled performance in tertiary flute players. *Psychol. Music* 41, 306–328.

Koo, T. K., and Mae, Y. L. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J. Chiropractic Med.* 15, 155–163. doi: 10.1016/j.jcm.2016.02.012

Kwan, P. Y. (2016). *The Effect of Music Performance Anxiety, Context, Modality and Observers' Music Expertise on Judgment of Musical Performances*. Jyväskylä: University of Jyväskylä.

Lartillot, O. (2021). *MIRtoolbox 1.8.1: User's Manual. MIRAGE Project, RITMO Centre for Interdisciplinary Studies in Rhythm, Time, and Motion*. Oslo: University of Oslo.

Lartillot, O., Eerola, T., Toiviainen, P., and Fornari, J. (2008). "Multi-feature modeling of pulse clarity: design, validation, and optimization," in *Proceedings of the International Conference on Music Information Retrieval*, Philadelphia.

Lartillot, O., and Toiviainen, P. (2007). "A Matlab toolbox for musical feature extraction from audio," in *Proceedings of the International Conference on Digital Audio Effects*, Bordeaux.

Laukka, P., Linnman, C., Åhs, F., Pissiota, A., Frans, Ö, Faria, V., et al. (2008). In a nervous voice: acoustic analysis and perception of anxiety in social phobics' speech. *J. Nonverb. Behav.* 32, 195–214. doi: 10.1007/s10919-008-0055-9

LeBlanc, A., Jin, Y. C., Obert, M., and Siivola, C. (1997). Effect of audience on music performance anxiety. *J. Res. Music. Educ.* 45, 480–496.

Matei, R., and Ginsborg, J. (2017). Music performance anxiety in classical musicians – what we know about what works. *BJPsych. Int.* 14, 33–35. doi: 10.1192/S2056474000001744

MATLAB (2021). *MATLAB (2021) [Computer software]*. Natick, MA: MathWorks.

Nunnally, J. C. (1987). *Teoriia Psicomeìtrica*. Meìxico: Trillas.

Osborne, M. S., Greene, D. J., and Immel, D. T. (2014). Managing performance anxiety and improving mental skills in conservatoire students through performance psychology training: a pilot study. *Psych. Well Being* 4:18. doi: 10.1186/s13612-014-0018-3

Papageorgi, I., Hallam, S., and Welch, G. F. (2007). A conceptual framework for understanding musical performance anxiety. *Res. Stud. Music Educ.* 28, 83–107. doi: 10.1177/1321103X070280010207

Peer, E., Brandimarte, L., Samat, S., and Acquisti, A. (2017). Beyond the Turk: alternative platforms for crowdsourcing behavioral research. *J. Exp. Soc. Psychol.* 70, 153–163. doi: 10.1016/j.jesp.2017.01.006

Rocha, S., Dias-Neto, E., and Gattaz, W. F. (2011). Music performance anxiety: translation, adaptation and validation of the Kenny music performance anxiety inventory (K-MPAI) to the Portuguese language. *Arch. Clin. Psychiatry* 38, 217–221.

Roland, D. (1994). How professional performers manage performance anxiety. *Res. Stud. Music Educ.* 2, 25–35. doi: 10.1177/1321103X9400200105

Schmid, P. C. (2016). "Situational influences on interpersonal accuracy," in *The Social Psychology of Perceiving Others Accurately*, eds J. A. Hall, M. S. Mast, and T. V. West (Cambridge, MA: Cambridge University Press), 230–252.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., and Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Spiro, N., and Schober, M. F. (2021). Discrepancies and disagreements in classical chamber musicians' characterisations of a performance. *Music Sci.* 4, 1–29. doi: 10.1177/20592043211011091

Stanley, M., Brooker, R., and Gilbert, R. (2002). Examiner perceptions of using criteria in music performance assessment. *Res. Stud. Music Educ.* 18, 46–56. doi: 10.1177/1321103X020180010601

Taylor, A., and Wasley, D. (2004). "Physical fitness," in *Musical Excellence: Strategies and Techniques to Enhance Performance*, ed. A. Williamon (New York, NY: Oxford University Press), 163–178.

Thompson, M. R., and Luck, G. (2012). Exploring relationships between pianists' body movements, their expressive intentions, and structural elements of the music. *Music Sci.* 16, 19–40. doi: 10.1177/1029864911423457

Thompson, S. (2006). Audience responses to a live orchestral concert. *Music Sci.* 10, 215–244.

Thompson, S., and Williamon, A. (2003). Evaluating evaluation: musical performance assessment as a research tool. *Music Percept.* 21, 21–41. doi: 10.1525/mp.2003.21.1.21

Vuoskoski, J. K., Thompson, M. R., Clarke, E. F., and Spence, C. (2014). Crossmodal interactions in the perception of expressivity in musical performance. *Atten. Percept. Psychophys.* 76, 591–604. doi: 10.3758/s13414-013-0582-2

Wapnick, J., Ryan, C., Lacaille, N., and Darrow, A. A. (2004). Effects of selected variables on musicians' ratings of high-level piano performances. *Int. J. Music. Educ.* 22, 7–20. doi: 10.1177/0255761404042371

Wells, R., Outhred, T., Heathers, J. A. J., Quintana, D. S., and Kemp, A. H. (2012). Matter over mind: a randomized-controlled trial of single-session biofeedback training on performance anxiety and heart rate variability in musicians. *PLoS One* 7:e46597. doi: 10.1371/journal.pone.0046597

West, R. (2004). "Drugs and musical performance," in *Musical Excellence: Strategies and Techniques to Enhance Performance*, ed. A. Williamon (New York, NY: Oxford University Press), 271–290.

Wilson, G. D., and Roland, D. (2002). "Performance anxiety," in *The Science and Psychology of Music Performance: Creative Strategies for Teaching and Learning*, eds R. Parncutt and G. E. McPherson (Oxford: Oxford University Press), 47–61.

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Yoshie, M., Kudo, K., and Ohtsuki, T. (2008). Effects of psychological stress on state anxiety, electromyographic activity, and arpeggio performance in pianists. *Med. Probl. Perform. Art* 23, 120–132. doi: 10.21091/mppa.2008.3024

Zarza-Alzugaray, F. J., Casanova, O., and Orejudo, S. (2016a). Music performance anxiety and related psychological constructs. Students of five Spanish music conservatories. *Rev. Int. Educ. Musical* 4, 13–24.

Zarza-Alzugaray, F. J., Hernández, S. O., Loìpez, O. C., and Gil, B. M. (2016b). Kenny music performance anxiety inventory: confirmatory factor analysis of the spanish version. *Psychol. Music* 44, 340–352. doi: 10.1177/0305735614567932

Zhang, J. D., and Schubert, E. (2019). A single item measure for identifying musician and nonmusician categories based on measures of musical sophistication. *Music Percept.* 36, 457–467. doi: 10.1525/mp.2019.36.5.457

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Repeated stage exposure reduces music performance anxiety

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Background: High heart rate (HR) and restlessness are two important features of music performance anxiety (MPA). In a case report of a cellist suffering from this condition, we showed that HR and restlessness decreased after repeated live performances of the same musical excerpt, thereby positively modulating objective performance criteria and subjective components. Here, we largely replicate these results in a group of 18 string players reporting MPA.

Methods: Objective measurement devices included a miniaturized electrocardiogram monitor and three 3-axis accelerometer loggers. Subjective measures included the Multidimensional Mental Health Questionnaire (MDBF) and a customized visual analogue scale (VAS) questionnaire for MPA. Non-artistic performance errors were assessed by music experts using a composite score for technical playing errors (i.e., intonation errors, omission of notes, and bowing noise). Data were collected from each study participant during three brief public solo performances of the same musical excerpt, with each performance occurring before a new audience on the same day.

Results: From the 1st to the 3rd performance, HR, VAS, and playing error scores decreased significantly. MDBF (RU scale) showed a significant increase in calmness from the 1st to the 3rd performance on stage. HR and RU, VAS, and RU, as well as bow acceleration and overall duration of playing correlated significantly across participants and performances.

Discussion and conclusion: We conclude that repeated stage exposure significantly reduces HR as well as restlessness and playing errors linked to MPA. Public performances are still successful when HR is significantly higher than during rest periods. These results underscore the importance of stage training to become accustomed to realistic public self-exposure. Musicians – especially students – should consider this component of stage training as an integral part of their practice routine. Therefore, stage training can reduce MPA, promote better live performances and prevent stress-related mental disorders and physical injuries. These result from excessive self-exercise strategies common in musicians experiencing MPA. HR monitoring should be an integral part of evaluating the effectiveness of interventions for better MPA management and efficient performance training.

KEYWORDS

music performance anxiety, stage fright, coping, stage exposure, musicians' medicine, musicians' health, music physiology

1. Introduction

MPA is a form of anxiety that manifests in unwanted and unpleasant physiological and psychological responses. Increased sympathetic activity is a prominent indicator of MPA (Yoshie et al., 2009; DeCaro et al., 2011; Kenny et al., 2014; Kenny and Ackermann, 2015; Jane, 2022). In addition, effects of MPA on neuro-endocrine regulatory systems have been identified (Gomez et al., 2018; Haccoun et al., 2020).

Along with psychological factors, for instance, lack of general self-confidence, identified as a major source of MPA (Kenny et al., 2014), musicians list somatic signs caused by excessive physical arousal before or during performance among the main causes of their MPA. In addition, solo performance has major negative effects on MPA (Kenny et al., 2014). Negative post-event rumination has been reported to promote performance anxiety (Nielsen et al., 2018; Guyon et al., 2020) even beyond the stage (Haccoun et al., 2020). The factors mentioned above are not limited to orchestral musicians. Many players – whether of strings or not – suffer from MPA (see for example Yoshie et al., 2009).

Some knowledge on MPA management techniques have been reported. For instance, practical experience with training to minimize performance anxiety shows that building a personal stage choreography, including clapping, bowing or reverences, can promote a competent on-stage behavior, which also contributes to greater confidence when performing (Hildebrandt and Nübling, 2004; Hildebrandt, 2009; Williamon et al., 2014). Practicing under stress, i.e., off-stage, has also a positive effect on performance under real-life conditions (Oudejans and Pijpers, 2009, 2010). The use of video cameras leads to a strengthening of the individual's self-perception and to a monitoring pressure that is typical for psychologically stressful situations (DeCaro et al., 2011; Papageorgi and Welch, 2020), therefore, it helps mimicking and practicing such situations.

Recent work has shown that not only the type of attention devoted to a motor task can improve or sustain skillful performance (Hildebrandt and Nübling, 2004; Mornell and Wulf, 2019) but also the timing at which an internal or external focus of attention is triggered. Using an internal focus of attention during performance preparation, then switching to an external focus of attention during performance, improves performance of a well-learned skill (Mornell and Wulf, 2019; Becker et al., 2020; Aiken and Becker, 2022) or at least is not detrimental to it (DeCaro et al., 2011). For example, DeCaro and colleagues have used distraction tasks designed to divert attention from an internal control focus while procedural tasks are performed under monitoring stress, and demonstrated their effectiveness (DeCaro et al., 2011). In other words, the focus of attention should be directed towards musical aspects, away from an error-oriented, analytical, and past-oriented focus. One could speak of a "musical memory training." Such training involves so-called "semi-mental" training methods (i.e., true-to-the-original simulated instrumental and performance movements without an instrument, including body movements) designed to trigger mental representations of the target sound and musical performance (Hildebrandt, 2010) The goal of such training is to strengthen and stimulate the auditory-movement association – a very important safety donor on stage.

The importance of constructive feedback for a better management of MPA has ben also reported. In particular, the ability to devise solutions and strategies aimed at correcting weaknesses and working through them constructively (Hildebrandt and Nübling, 2004; Hildebrandt, 2009, 2010). The help of a constructively oriented audience to dampen the very common destructive review of undesirable outcomes (Nielsen et al., 2018; Studer et al., 2019; Guyon et al., 2020; Haccoun et al., 2020) that have been related to MPA, has been discussed to help construct a perspective for future performance (Brodsky, 1996, 1999; Hildebrandt, 2009).

Among other effects, sympathetic activation shortens cardiomyocyte action potentials, increasing HR (i.e., positive chronotropy) and shortening atrioventricular conduction (i.e., positive dromotropy; Schmidt et al., 2019). Parasympathetic activation reverses both (i.e., negative chronotropy; negative dromotropy; Schmidt et al., 2019). Thus, an important marker of increased sympathetic activity, and therefore of MPA, is a higher HR (Schmidt et al., 2019). Not surprisingly, several authors have included HR measurements in studies on for example stress during sports (Oudejans and Pijpers, 2009, 2010; Kusserow et al., 2010), repeated psychosocial stress induced by real and virtual stressors, including the same stressor over different periods of time (Schommer et al., 2003; Kothgassner et al., 2021, 2022), acute psychological stress (Trotman et al., 2019) and MPA (Yoshie et al., 2008; Yoshie et al., 2009; Kusserow et al., 2012; Kenny et al., 2013; Studer et al., 2014). In addition to HR, several authors have used heart rate variability (HRV) in the context of sports and exercise psychology to measure stress (Mosley and Laborde, 2022).

Experience can modulate mental and somatic responses mediated by sympathetic nervous system activity and thereby positively affects performance outcomes (Oudejans and Pijpers, 2009, 2010; Kusserow et al., 2012). Other authors have already demonstrated habituation of sympathetic responses to repeated psychosocial stress induced by real and virtual stressors (Kothgassner et al., 2021). Higher heart rates (i.e., higher sympathetic activity) have been shown to decrease significantly (i.e., lower sympathetic activity) after repeated exposure to the same stressor – in this study, a live audience – over different periods of time (Schommer et al., 2003; Kothgassner et al., 2021, 2022).

In this study, we tested the effects of experience on MPA levels using repeated live performances of the same musical excerpts in a group of string players who reported MPA. To our knowledge, apart from our previous case report (Kusserow et al., 2012), no similar study has been conducted. With the present study, we aimed to replicate the findings of the case report in a group of musicians affected by MPA. We aim to contribute to management techniques for MPA by reporting the effects of an intervention on momentary MPA (i.e., repeated live performances of the same musical excerpts within a day) and its objective and subjective evaluation. The prototypical set we tested is a key component of a successful stage training program conducted since 1998 at the Zurich and Basle Universities of Music (Hildebrandt, 2009, 2010).

To assess the effects of repeated live performance on the physiological and psychological components of MPA (i.e., stress desensitization) under comparable, real-world stress conditions, we created a performance situation in a highly demanding environment. It consisted in repeated solo performances in front of live professional audiences (Kenny et al., 2014; Papageorgi and Welch, 2020) differing between each performance. This added a dimension of implicit social appraisal identified as a key component of manipulating psychosocial stress and eliciting physiological stress reactivity (DeCaro et al., 2011). We measured physiological and

psychological responses in string players, who represent one of the largest populations of musicians (Steinmetz et al., 2015) for whom we presented MPA monitoring data in the past (Kusserow et al., 2012).

To replicate a previous case report on MPA monitoring (Kusserow et al., 2012), we used HR as an objective indicator of MPA and assessed changes in HR before, during, and after the live performances. We correlated these changes with subjective assessments of MPA and with a standard measure of mood during three short public solo performances of the same musical excerpt, each on the same day and in front of a new audience. To monitor movement dynamics, we used accelerometers.

Evaluating HR alone to identify stress responses can be misleading because physical activity itself can act as a confounding variable. For this reason, we compared HR during performance and during play-free time by comparing HR while hopping in place for 60 s (baseline of maximal physical activity) with HR during performance. It needs to be stated that, in our previous case report (Kusserow et al., 2012), we compared exercise in daily life as recorded in a diary of activities performed during the day as exercise baseline. Therefore, maximal physical activity at baseline was better controlled in the study presented here, as all participants performed the same physical activity for the same amount of time.

In the past, technical and artistic components were used to evaluate the quality of a musical performance during MPA (Yoshie et al., 2009). The evaluation of artistic components, however, is difficult to reproduce. In this series of measurements, we therefore chose not to evaluate the artistic component. As in our previous case report (Kusserow et al., 2012), we used a manual, expert-based assessment of technical performance errors to determine the technical quality of the performance only. Technical components such as pitch (e.g., the correct note, note omissions) and rhythm can be better determined from the score and subjective impressions. For example, intonation quality has been shown to be a good predictor of listeners' performance ratings (Johnson and Geringer, 2007), and some authors have shown that pitch errors are the easiest errors to notice (Doane, 1989; Waggoner, 2011).

We hypothesized that repeated stage exposure with the same musical excerpts would positively modulate MPA. Specifically, we hypothesized decreased HR, lower VAS scores for MPA, higher subjective well-being and calmness, fewer performance errors and, in addition, changes in bow movement dynamics from the first to the third performance.

2. Methods

2.1. Participants and ethics

The 18 string players (12 violin, 1 viola, 5 cello; 12 female, 6 male; mean age 21.11 SD 2.25; see Table 1 for comprehensive demographic data) gave their written informed consent prior to participation.

Requirements for participation in the study were an age between 18 and 35 years, no cardiac, respiratory, or metabolic problems, no diseases of the nervous system, including psychiatric diseases or diseases of the musculoskeletal system. No use of medications that affect the nervous system, cardiovascular system, or respiratory system, especially no use of beta-blockers. No health problems associated with the performance of athletic maneuvers such as jumping on the spot for 1 min (Table 2).

TABLE 1 Demographic data of participants.

Study Participants	Gender	Age	Instrument
1	Female	19	Violine
2	Female	20	Violine
3	Female	20	Violine
4	Female	20	Viola
5	Female	21	Violine
6	Female	21	Violine
7	Male	22	Cello
8	Male	19	Violine
9	Male	27	Violine
10	Female	22	Cello
11	Female	23	Violine
12	Female	21	Violine
13	Male	21	Cello
14	Male	19	Violine
15	Male	21	Cello
16	Female	23	Violine
17	Female	17	Cello
18	Female	24	Violine
	Mean	21.11	
	SD	2.25	

TABLE 2 Measurement methods and parameters.

Parameters measured	Methods
Objective measurement devices	
Heart rate (HR)	One lightweight (10 g) ECG-monitor (sampling rate = 256 Hz)
Body movement	Three 3-axis accelerometer loggers attached to: - the outside of both forearms at the wrist – to measure movement during playing - the left thigh above the knee – to measure total body movement (sampling rate = 32 Hz (range ± 4 g)
Subjective measurement tools	
MPA-level	10-item VAS (1 = no MPA, 10 = extreme MPA)
Level of current mental well-being	Multidimensional mental health questionnaire (MDBF); contains three bipolar dimensions of current mental well-being: 1) good-bad mood (GS) 2) alertness-fatigue (WM) and 3) rest-restlessness (RU)

The study was conducted according to the guidelines of the Declaration of Helsinki[1] for the treatment of experimental subjects. The local Ethical Committee at ETH Zurich approved the study protocol (EK 2010-N-57). The study was carried out at the Zurich University of the Arts (partner institution for this study). Participants received a monetary compensation of 30 Swiss Francs for their participation.

1 http://www.wma.net

2.2. Objective data

A wearable system recorded cardiac activity and body movement simultaneously. The system consisted of an electrocardiogram (ECG) monitor (CamNtech, model: ActiwaveCardio, http://www.camntech.com/cntcardio.htm) and three 3-axis accelerometer loggers (Kusserow et al., 2010, 2012). The ECG monitor was a lightweight (10 g), single-channel waveform recorder with an integrated 3-axis accelerometer. It was attached to the chest of the musicians with two ECG electrodes (Ag/AgCl, 254mm^2); the sampling rate was 256 Hz. The accelerometers were attached to the outside of both forearms at the wrist to measure movement during playing, and to the left thigh above the knee to measure total body movement at baseline (see below for more details). The sampling rate for the accelerometers was 32 Hz (range ± 4 g). The sensors were worn comfortably under the musicians' clothing and did not interfere with their activities or performances (Kusserow et al., 2012). For a graphical representation of the multi-sensor system, see Figure 1 in Kusserow et al. (2012).

All participants were recorded with the multi-sensor recording system, first at baseline, which consisted of a 60 s hopping on the spot after a standing quietly (baseline of maximal physical activity), and then during the live performance. The recording system remained attached to participants until their final performance on stage.

2.3. Subjective data

Before and after each performance, musicians were in the practice room to self-evaluate their live performance in terms of MPA level using a 10-item VAS (1 = no MPA, 10 = extreme MPA). In addition, they completed MDBF scales on the level of calmness and composure and on mood and alertness (Steyer et al., 1997).

We included the MDBF to control for current psychological well-being, i.e., well-being during measurements, because differences along the GS and WM scales would indicate changes in mood over time (i.e., more fatigue or low mood), both dimensions are known to influence experimental measurements in general. In addition, the MBDF contains a dimension that is closely related to psychological components associated with MPA, namely the degree of rest-restlessness. We did not include the Kenny Music Performance Anxiety Inventory because the questionnaire cannot provide information about current mood during – for instance – MPA episodes. In addition, to our knowledge, a validated German version of the K-MPAI was still pending by the time of measurements. The Multidimensional Mental Health Questionnaire (MDBF) consists of 24 items (each with a five-point response scale) to measure three bipolar dimensions of current mental well-being: good-bad mood (GS), alertness-fatigue (WM) and rest-restlessness (RU). All three scales can be divided into two parallel test halves each, which can be used to measure mental well-being over time. The internal consistency (Cronbach's alpha) of the scales for the long form lies between $\alpha = 0.86$ and $\alpha = 0.94$, for the short forms between $\alpha = 0.73$ and $\alpha = 0.89$.[2] Participants did not receive feedback on the quality of their performance.

2.4. Performance protocol

2.4.1. Warm-Up

Before each performance, participants were not allowed to warm up for more than 3 min. To increase performance stress, participants were not allowed to warm up with passages they were going to perform on stage. About 2 min before the performance began, they left the practice room and walked over to the concert hall and onto the stage.

2.4.2. On stage

All participants played their pieces from memory. During the performances, the violinists and the violist played in standing position.

2.4.3. Audience and music pieces

A rotating audience of 15–20 people per performance, including professional-level music students and teachers, was present for all live performances. The musicians played the same piece of music in all three performances. Time interval between appearances on stage was about 1.5 h and were accompanied by a professional pianist when needed. Participants were asked to self-select the pieces they found most challenging and particularly well suited to trigger their MPA.

2.5. Analysis procedures

Audios and videos of the performances were recorded for later evaluation of the technical, non-artistic, quality of the performance. The beginning and end of each performance were determined by hand. Segmentation of data was performed using MATLAB software (MathWorks Inc., Natick, MA; http://www.mathworks.com/).

2.5.1. Computation of HR and body motion

Heart beat series (RR-intervals) were computed using a free implementation[3] of the Pan-Tompkins-Hamilton algorithm (Hamilton and Tompkins, 1986). To get a uniform sampling, heartbeat series were interpolated, matching the sampling of the corresponding body motion data (acceleration). The HR series x_{HR} in beats·min^{-1} (bpm) was computed from the heartbeat time series x_{RR} (in ms) by $x_{HR} = 6 \cdot 10^4 \cdot x_{RR}{}^{-1}$. To obtain a representation for overall body motion dynamics, we computed the L2-Norm $\|(a_x, a_y, a_z)\|$ from the three axes of an acceleration sensor. To omit static acceleration components, the three acceleration axes were high-pass filtered (first order Butterworth filter, cut-off frequency 0.1 Hz).

2.5.2. Computation of relative duration of execution

To assess the relative changes in playing time for each performer, we calculated the relative change in duration of execution by dividing the total duration of execution at the 3rd performance by the total duration of execution at the 1st performance. Therefore, values >1 indicated longer playing times during the 3rd performance compared with the 1st performance; values <1 indicated shorter playing times during the 3rd performance. Relative changes were presented as percentage differences.

2 https://www.testzentrale.ch/shop/der-mehrdimensionale-befindlichkeitsfragebogen.html#1+1

3 http://www.eplimited.com

2.5.3. Assessment of non-artistic performance quality

Non-artistic performance errors were assessed by music experts using a composite score for technical playing errors: intonation errors, omission of notes, bowing noise).

Software developed in MATLAB was used to slice all complete audio samples into segments of equal length (3 s). The segmented audio samples were played to two professional musicians. Ratings were made by listening together to all individual excerpts from each performer for each of the three live performances. The experts collectively agreed on error categories and errors that fell into those categories for each segment. Only errors for which there was complete agreement among the evaluators were considered. The following categories of playing errors were considered: incorrect intonation, note errors (i.e., missing notes, rhythmic errors), and bowing errors (i.e., poor sound production such as bow whistles). Musical notes that had two or all three types of errors were assigned one error score per error category. We summed the number of technical playing errors from all three categories to obtain a composite score that represented an individual technical performance score for each performance (i.e., 1st, 2nd, and 3rd performance) and each player.

2.5.4. Statistical analyses

Where appropriate, the Friedman Test, Wilcoxon Signed Rank Test, Spearman rank correlation, and Mann–Whitney U Test as well as Pearson's r were used. For all comparisons, the significance level was set at $p < 0.05$. Our hypotheses would be effectively one-sided, considering that we tested based on our previous case report. Nevertheless, we report the two-sided test values here to avoid overestimating results; the one-sided p-value can be obtained by dividing the reported p-values by two.

2.6. Results

2.6.1. Lower HR after repeated performances

The Friedman Test for changes in HR, including baseline (a 1 min run of hopping on the spot) and the three live performances, revealed highly significant changes ($p = 0.00001$). Individual *post-hoc* comparisons using the Wilcoxon Rank Test showed significant changes [HR during baseline < HR during 1st performance ($p = 0.028$); HR during baseline > HR during 3rd performance ($p = 0.048$); HR during 1st performance > HR during 2nd performance ($p = 0.0002$) and 3rd performance ($p = 0.0002$); HR during 2nd performance > HR during 3rd performance ($p = 0.0005$); see Figure 1].

2.6.2. Subjectively less MPA after repeated performances

The Friedman Test for the tailored MPA questionnaire for subjectively perceived performance anxiety (VAS: 10 = MPA at maximum) showed highly significant changes ($p = 0.0009$). Individual post-hoc comparisons using the Wilcoxon Rank Test revealed the following results: 1st performance scores >2nd performance scores ($p = 0.001$); 2nd performance scores >3rd performance scores ($p = 0.0278$); 1st performance scores >3rd performance scores ($p = 0.00038$; see Figure 2).

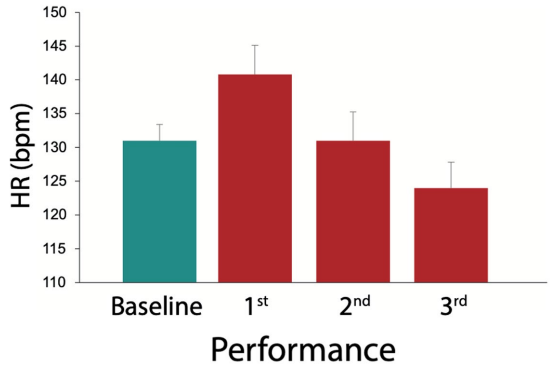

FIGURE 1
Heart rate (HR). HR changes from baseline to 3rd performance. Baseline (green) consisted of a 1min run with hopping on the spot. Bars 2 to 4 (red) show HR during on-stage performance from 1st to 3rd performance. Shown are means and standard error (S.E.) of means.

2.6.3. Unchanged MDBF GS and WM scores

The Friedman Test for the good-bad mood (GS) and alertness-fatigue (WM) scales of the MDBF did not show significant changes.

2.6.4. Higher MDBF RU scores from 1st To 3rd performance

The Friedman Test comprising the average of pre and post scores for all three performances for the RU scale of the MDBF (i.e., degree of rest-restlessness) revealed significant differences ($p = 0.00637$). Scores for the 1st compared to the 2nd assessment slightly failed to achieve significance ($p = 0.0561$). Higher scores of rest-restlessness were reported for the 3rd compared to the 1st assessment ($p = 0.0164$) and the 3rd compared to the 2nd assessment ($p = 0.029$). All individual comparisons were made using the Related-Samples Wilcoxon Signed Rank Test (see Figure 2).

2.6.5. HR and RU correlated negatively across participants and performances

There was a highly significant negative correlation between HR and RU scores (Spearman's rank correlation across participants and performances ($r = -0.54$, $p = 0.000030$; see Figure 3).

2.6.6. VAS and RU correlated negatively across participants and performances

There was a negative VAS and RU-MDBF correlation when calculated across all participants and all three performances (Spearman's rank correlation $r = -0.4$ $p = 0.00155$). Note that one participant gave a VAS rating of 1 to all three performances while his HR pattern was like the one of the other participants; he could therefore be considered an outlier. A recalculation without this participant resulted in a Spearman's rank correlation of $r = -0.54$ $p = 0.00005$; see Figure 3).

2.6.7. Lower error scores after repeated performances

The total errors (i.e., intonation, note omissions, bowing errors) rated by two experts differed significantly among the three live performances (Friedman Test $p < 0.00001$). All individual comparisons

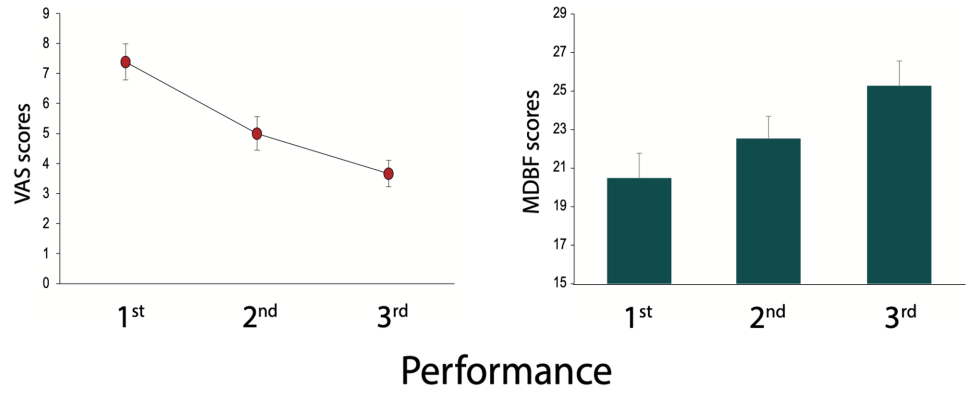

FIGURE 2
MPA-Questionnaire and MDBF-Questionnaire MDBF (RU scale). Tailored MPA questionnaire (**left**; VAS: 10=MPA at maximum). MDBF (RU scale; **right**), which indicates the degree of rest-restlessness. Higher values mean more calmness and serenity. Shown are mean values and S.E. of the means.

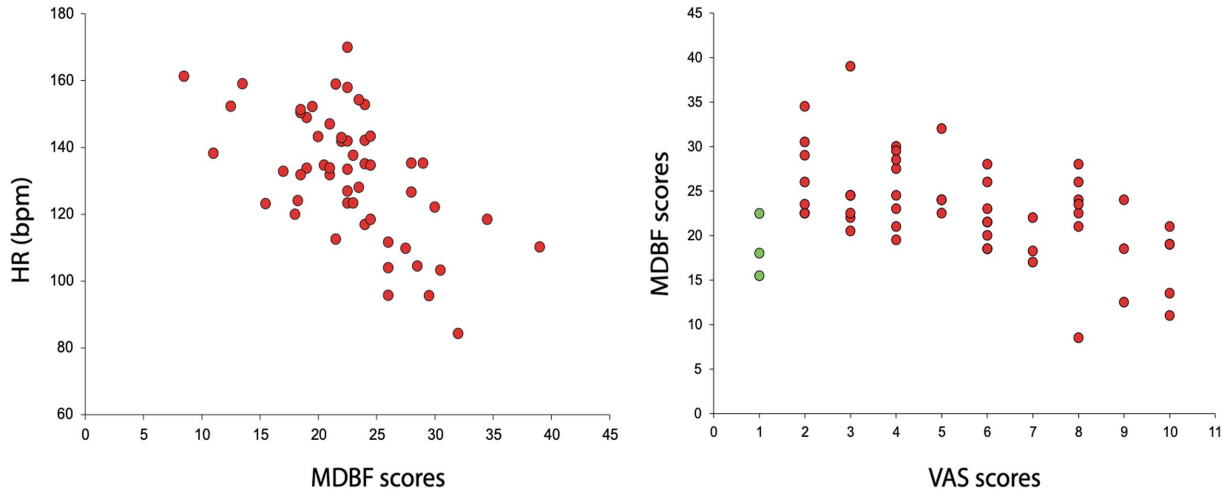

FIGURE 3
HR and RU correlation **(left)**, VAS and MDBF correlation **(right)**. Negative HR and RU Spearman's rank correlation across participants and all three performances. Shown are all three RU scores and HR values for each participant **(left)**. Musicians with higher HR scores reported being less calm. Spearman's rank correlation of negative VAS and RU **(right)** calculated across participants and all three performances. Shown are all three RU and VAS scores for each participant. The green dots represent the VAS scores of the only participant who scored all three performances with a 1.

using the Related-Samples Wilcoxon Signed Rank Test were significant: number of errors during 1st performance > number of errors during 2nd performance ($p = 0.00036$); number of errors during 2nd performance > number of errors during 3rd performance ($p = 0.0018$); number of errors during 1st performance > number of errors during 3rd performance ($p = 0.0002$; see Supplementary Figure 1).

2.6.8. Two different patterns of overall duration of execution across performances

Analysis of differences in duration of execution from the 1st to the 3rd performance, expressed as percentage changes, revealed two groups with opposite patterns of overall playing speed (Mann–Whitney U, two-sided test. U value = 0, critical value of U at $p < 0.05 = 15$, $p = 0.00044$): One group (G1 $n = 9$) played faster during the 3rd performance, whereas the other group (G2 $n = 8$) played slower. One participant from G1 was excluded because her playing time was artificially prolonged due to memory lapses, which made the 1st performance slower. Note that including this participant would have made the differences even stronger; see Figure 4).

2.6.9. HR split by duration of execution was similar between subgroups

Percentage changes in HR from 1st to 3rd performance did not differ between G1 and G2 subgroups (Mann–Whitney U value = 23, critical value of U at $p < 0.05 = 15$, $p > 0.05$), nor did they differ in baseline HR (Mann–Whitney U: U value = 35, critical value of U at $p < 0.05 = 15$ $p > 0.05$). Individual comparisons between subgroups and corresponding performances (e.g., G1, 1st performance vs. G2, 1st performance) were not significant (Mann–Whitney U, $p > 0.05$, for all three comparisons). Friedman Tests for G1 and G2 separately, were both significant (G1 $p = 0.0003$; G2 $p = 0.00034$). Individual post-hoc comparisons using the Sign Test for both groups separately yielded the following results: G1 1st > 2nd z-value = 3, $p = 0.0027$; 2nd > 3rd performance: z-value = 2.33, $p = 0.01963$; 1st > 3rd: z-value = 3,

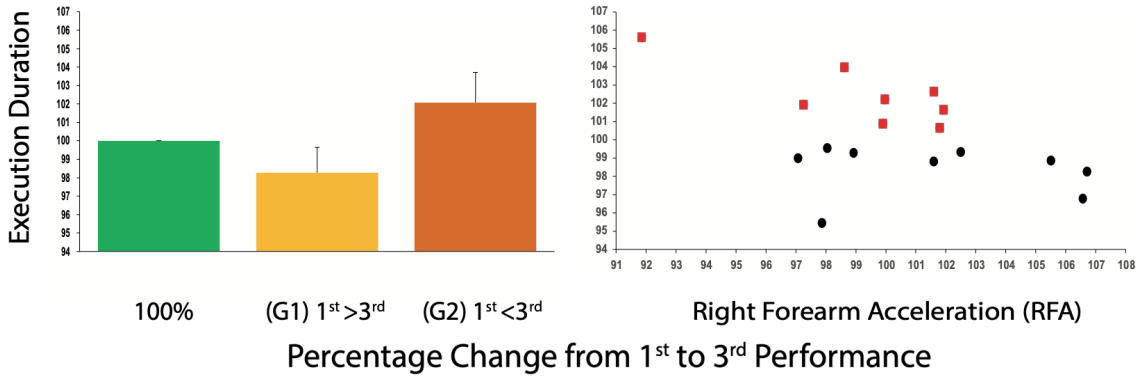

FIGURE 4
Changes in Overall Execution Duration **(left)** and Percentage Change in Right Forearm Acceleration (right), from 1st to 3rd performance. One group played faster (G1 n=9) the other group (G2 n=8) played slower during the 3rd performance **(left)**. 100% is shown for clarity, as a reference. On the right side, all participants split according to relative execution duration correlated to percentage changes in right forearm acceleration. Red squares represent G2 (longer execution duration at the 3rd performance).

$p = 0.0027$. G2 1st > 2nd: z-value = 2.83, $p = 0.00468$; 2nd > 3rd performance: z-value = 2.282, $p = 0.00468$; 1st > 3rd: z-value = 2.83, $p = 0.00468$ (note that the reduced number of n-participants per group did not allow calculation of an exact p-value using the Related-Samples Wilcoxon Signed Rank Test; see Figure 4).

2.6.10. Uncorrelated percentage changes in RFA and HR

Percentage changes in right forearm (i.e., bow's arm) acceleration (RFA) were not correlated with percentage changes in HR ($r = -0.0008$, $p > 0.05$). Percentage changes in duration of execution were also not correlated with percentage changes in HR ($r = -0.32$, $p > 0.05$). This was also true for both subgroups.

2.6.11. Moderate and negative correlations for percentage changes in duration of execution and percentage changes in RFA-values

The Pearson's r for the correlation of the percentage changes in duration of execution with the percentage changes in RFA values was −0.51 ($p = 0.036484$), indicating a moderately negative relationship, with bow acceleration accounting for 26% of the changes in duration of execution from first to 3rd performance (see Figure 4).

Percentage changes in HR did not correlate with percentage changes in RFA ($r = -0.0008$, $p > 0.05$). This was also true for both subgroups.

3. Discussion

3.1. Overview of the obtained results

In this study, we showed that repeated live performances with the same musical excerpts lowered HR, led to less subjective MPA and more calmness among participants. HR and level of calmness were negatively correlated: the higher the measured HR, the less calmness among participants. In addition, repeated live performances resulted in lower error scores, most notably, without additional off-stage practice. Analysis of differences in duration of execution from the 1st to the 3rd performance revealed two groups with opposite patterns of overall playing speed: one group played faster at the 3rd performance; the other group played slower. The groups did not differ in HR from 1st to 3rd performance, nor did they differ in baseline-HR or individual comparison of the three different time points. When analyzed separately, both subgroups showed similar HR patterns to all participants when considered as a single group. Percentage changes in RFA were moderately and negatively correlated with percentage changes in duration of execution, with bow acceleration explaining 26% of the changes in duration of execution from the 1st to the 3rd performance. It is noteworthy that percentage changes in RFA and in duration of execution did not correlate with percentage changes in HR. This was also true for both subgroups.

3.1.1. HR physical versus mental components

The patterns of HR across live performances cannot be explained by physical activity alone. For instance, physical activity reached its maximum during baseline (i.e., hopping on the spot for 1 min), and not during performances on stage. The patterns of HR changes were also consistent even when the data were analyzed based on the different patterns of duration of execution. Our data confirms once more that experience can modulate mental and somatic responses mediated by sympathetic nervous system activity positively affecting performance outcomes (Oudejans and Pijpers, 2009, 2010; Kusserow et al., 2012). It also confirms the habituation of sympathetic responses to repeated psychosocial stress induced by real and virtual stressors (Kothgassner et al., 2021), with heart rates significantly decreasing after repeated exposure to the same stressor over different periods of time (Schommer et al., 2003; Kothgassner et al., 2021, 2022).

Because the percentage difference in RFA in both subgroups from 1st to 3rd third performance was minimal (+1.6% for G1 and −0.07% for G2), the changes in RFA cannot explain the observed changes in HR from 1st to 3rd performance.

3.1.2. Baseline

An appropriately elevated heart rate - i.e., under physiological stress conditions such as running - is appropriate to the challenge of the environment and can be discharged by the large striated muscle groups. Similar arousal during a musical performance would be less appropriate because it leads to undesirable physiological responses

such as tremors, arch tremors, restlessness as non-functional ways to discharge the excessive sympathetic arousal. Nevertheless, there were no complains on such non-functional discharges of excessive sympathetic arousal and no such signs were evident during evaluation of errors in the selected excerpts. For example, bow errors accounted for 18, 20, and 23 percent of the errors during the 1st, 2nd, and 3rd performances, respectively. In the case of adverse physiological responses, one would expect a higher number of for example bow errors during the 1st performance because this performance was closer to baseline, the only time when jumping on the spot was introduced. Because percentages of bow errors remained fairly unchanged across performances, we conclude that the physical challenge we used as a baseline did not interfere with the results.

3.1.3. Sympathetic reactivity over the three performances

Time interval between appearances on stage was about 1.5 h, during which no practice or passage corrections with the instrument were allowed. Therefore, we cannot completely rule out the possibility that the decreasing sympathetic reactivity across the three performances was due in part to the depletion of adrenaline, simply because the performances occurred in close succession. This would indeed be a general effect one would expect after repeated performances on stage. Nevertheless, we are convinced that the repeated performance of the same piece of music in front of a changing audience played a significant role in the marked changes in HR. In other MPA investigations performed on 1 day those who had previously performed a Debussy piece had significantly lower HR (Kenny et al., 2013). However, it could also be that both the repeated performance on stage and the repeated performance of the same pieces in front of an audience had a combined, and strong desensitizing effect.

A similar study with performances on consecutive days or a few days apart with the same and different repertoires could provide new insights but would introduce a confounding factor that we neutralized here, namely more practice hours between performances. In the present study, we could rule out the results being explained by more physical training, a strategy reportedly used to cope with MPA, for which our results offer an alternative.

In future studies, resting HR could also be measured in time-lapse, including a few days before performance. For example, this would reveal HR profiles as the day of performance approaches and hours and days after performance. The information could be correlated with validated measures of state anxiety, fear of negative evaluation or amount of MPA.

3.1.4. Changes in RFA

Since the changes in RFA were not correlated with HR and there was no opportunity to practice between the three performances, perhaps they show the different degree of confidence in the performed pieces due to an on-stage practice effect.

3.1.5. Mental components as a function of the MPA level

In total, body acceleration remained unchanged from the first to the third performance, thus it cannot explain the observed changes in HR. We conclude that HR changes, as observed here, most likely depend on changes in mental components as a function of the MPA level.

In the present work, as in our previous work (Kusserow et al., 2012), we were not interested in clarifying exactly which mental components are responsible for the changes in HR. In fact, we consider it one of the contributions of both studies to show that it is possible to separate physical and mental components contributing to the observed HR during MPA episodes. The amount of physical exercise during performance cannot explain the observed changes in HR (especially during the first performance), so we conclude that mental factors are responsible. This conclusion is entirely in line with previous work examining HR responses during practice and training compared to HR responses under evaluation and competition conditions when the same tasks – with the same physical content – were performed (Yoshie et al., 2008, 2009; Kusserow et al., 2010). Future research could shed light on specific mental components of MPA and HR, such as whether subjects with high fear of negative evaluation (FNE) show particularly high HR responses compared to MPA subjects with low FNE when measured over time following an MPA management intervention. This seems plausible, as athletes with high FNE showed a significant increase in anxiety associated with lower performance in stressful situations (Mesagno et al., 2012), and anxiety and HR have been shown to be higher during evaluation and stress conditions (Noteboom et al., 2001; Yoshie et al., 2008, 2009; Kusserow et al., 2010, 2012). We can only speculate about what mental elements are at work in this series, as they have not been the focus of our attention. Some or all participants in our group may have had negative thoughts during performance, especially during the first performance. This is related to the mental components of anxiety, such as in testing situations, also known as cognitive performance anxiety or CPA. Recently, it has been shown that individuals with high trait CPA have higher anxiety levels and attention to negative thoughts (Angelidis et al., 2019), which can have a negative impact on performance. In addition, musicians instructed to use an internal attentional focus during performance performed worse on the technical and musical aspects of their performances than those instructed to use an external attentional focus (Mornell and Wulf, 2019). Although we did not ask about the thoughts participants had during performance, the lower number of errors, higher MDBF scores, lower MPA scores on the VAS, and lower HR from the first to the third performance suggest that if affected, participants were less affected by the two performance-impairing cognitions mentioned above from performance to performance.

3.1.6. Somatic and cognitive manifestations

Future work should consider that somatic and cognitive manifestations are at least partially independent of each other – some have mainly somatic anxiety, others mainly cognitive, others a combination of both. In the latter group, somatic manifestations may be high, cognitive low, or vice versa. They may also have one or the other manifestation, depending on how close the performance is and the type of performance (e.g., "stake"). Each of these subsets of MPA manifestations, if adequately determined, may show a different pattern of HR responses. However, assuming that in our sample there might be one or more representatives of one of the groups with different somatic and cognitive manifestations of anxiety, the consistency of HR profiles across participants in this series, in our previous case report (Kusserow et al., 2012), and in reports on sports competitions (Kusserow et al., 2010) suggest(s)

that HR responses are less vulnerable to somatic and cognitive manifestation of MPA. Moreover, our assumptions are consistent with other studies in the field of music performance. Previous data on physiological responses of music students on stage, particularly data on cardiac and respiratory responses, already revealed comparable physiological responses in those with high subjective ratings of anxiety and those who rated themselves as having low anxiety on stage (Studer et al., 2011a, 2012, 2014). Finally, the heterogeneous group we studied in the context of MPA interventions is most likely representative of the type of populations one would encounter in a Western music high school where musicians are trained with classical virtuoso repertoire – underscoring the general relevance of our findings.

3.1.7. Duration of execution

Trait differences have been considered in the past in the context of MPA, for example, when examining predictors of MPA during skilled performance of musical pieces (Kenny et al., 2013). Such underlying differences may be evident not only in psychometric measures but also in physical parameters. For instance, consequences of stress are freezing and the limiting of movement amplitudes (Higuchi et al., 2002), increased arm stiffness and decreased force regulation during arpeggio performance in skilled pianists (Yoshie et al., 2008), and less well-controlled force during a pinch grip (Noteboom et al., 2001) – the latter being closely related to the performance of left and right hand movements in string instruments. In our previous case report, we also found that 3rd performance was faster in comparison to first performance (Kusserow et al., 2012). Therefore, we expected that the analysis of variations in duration of performance would reveal some differences in movement profiles related to MPA. Although the small number of participants precludes solid conclusions, the variable 'duration of execution' revealed two distinct subgroups in the collective measured here. The one subgroup showed too much drive to move (i.e., it was unfrozen and played faster at first performance), whereas the other showed the opposite pattern (i.e., it was frozen and played slower). Thus, these movement responses may represent two distinct and innate responses to dysregulated arousal as caused by anxiety and should be considered in future research aimed at implementing better management strategies for MPA (i.e., some individuals may need to be energized while others may need to be calmed to a medium level of arousal prior to performance).

3.1.8. HR and subjective MPA scores

The participants' subjective impression of their MPA and calmness scores largely mirrored HR patterns. In addition, VAS and MDBF scores were negatively correlated across participants and performances, highlighting the strong agreement between the subjective data. Furthermore, the negative correlation between HR and RU-MDBF across all participants and all three performances rounded out the analyses, showing congruency between physiological measures and subjective data.

Overall, these results are largely consistent with our previous case report (Kusserow et al., 2012) and clearly separate physical from mental components triggering HR responses during MPA episodes. Therefore, we consider HR patterns as key parameters in the investigation and evaluation of MPA, for instance, MPA management interventions.

There are some limitations to some of the methods we used. For instance, the subjective data collected relied on individual participants' understanding of MPA. Therefore, we did not define MPA for each participant before asking them to rate their own MPA. In addition, the questionnaire did not include questions about physiological symptoms such as hand sweating or muscle stiffness, two important symptoms indicative of higher MPA. These limitations arose in part from the fact that we wanted to replicate previous findings reported in a single case report (see (Kusserow et al., 2012). Certainly, a unidimensional VAS alone would be not adequate to assess the complex multi-factorial nature of MPA. For this reason, we correlated VAS and MBDF to in part limit this shortcoming. In other research on MPA in experienced musicians, some authors have also used 10-point scales in conjunction with other measures to have participants rate their level of pre-performance nervousness (Kenny et al., 2013). In this series, as in our previous case report (Kusserow et al., 2012), we avoided making explicit references to physiological symptoms and commenting on performance quality because any explicit mention would risk triggering an internal attentional focus (Mornell and Wulf, 2019), and fear of negative evaluation (Watson and Friend, 1969), both of which have the potential to increase anxiety (Kenny et al., 2013; Mornell and Wulf, 2019), and therefore affect measured parameters across performances (i.e., over time). Future research should incorporate other validated questionnaires to accurately measure immediate anxiety. For example, the Immediate Anxiety Measures Scale (IAMS) provides valid and reliable cognitive and somatic anxiety scores and can be used to measure task-specific anxiety. It has been correlated with HR reactivity measured in a single session (Trotman et al., 2019). In addition, the certified German translation of the K-MPAI – R could be used (Kenny, 2017) as all translated versions appear to have adequate reliability to measure anxiety levels (Antonini Philippe et al., 2022).

Future research should incorporate trait measures, measures of overall MPA (e.g., K-MPAI) and/or a measure of self-efficacy and/or depression. These measures could be then correlated with objective measures such as HR, or to changes in MPA over much longer periods of time to validate changes after longer periods of intervention.

3.1.9. The proper context to manage against MPA

We believe that the context we created is well suited for studying and training how to deal with MPA. We created a solo-performance environment directly comparable with real audition settings, which also contained several social-evaluative factors. These have been reported to be major triggers of explicit monitoring, a form of disruptive and excessive attention to skill processes and procedures during the performance of well-learned, complex motor tasks (DeCaro et al., 2011; Guyon et al., 2022; Sokoli et al., 2022). For instance, the audience included professional musicians and advanced music students, and appearances were videotaped. The data obtained, especially the HR, show that the participants considered the situation as a real performance consistent with performance under pressure (Baumeister, 1984). Some of the effects observed here have also been observed in other performances under pressure: For instance, high levels of performance anxiety were indicated by higher HR activity on the day of the concert (Hildebrandt et al., 2012), in solo performances with direct or indirect assessment (Yoshie et al., 2009; Hildebrandt

et al., 2012; Kusserow et al., 2012; Papageorgi and Welch, 2020), and in sports (Kusserow et al., 2010). We also increased stress by preventing participants from rehearsing or warming up with the excerpts they were about to perform (even between performances). The measurement situation was thus clearly a demanding one (DeCaro et al., 2011; Papageorgi and Welch, 2020).

3.1.10. Selection of pieces

One possible limitation of the study is that there was no prior measurement of technical mastery, nor was there any measure of familiarity or prior performance history of the excerpts selected. This is worth noting because some authors have shown that experience with test pieces can affect muscle tension and heart rate (Kenny et al., 2013). Musicians were asked to select a musical excerpt that, in their personal experience, would trigger their MPA. For some musicians, even technically less difficult pieces may trigger MPA if there was additional underlying psychopathology, which we did not completely control for (see Methods section for the inclusion and exclusion criteria). However, even in the absence of psychopathology, the degree of technical difficulty and the evaluation of that difficulty are subjective: neither a perfect nor an imperfect rendition (musically and technically speaking) would indicate that MPA has or has been not triggered. This was an important reason why we asked the musicians to self-select the pieces that triggered their MPA and why we compared each set of three performances individually (i.e., each performance of each person was compared with itself, i.e., three renditions of the same excerpt in a time distance of about 1.5 h). In contrast to our report, Kenny et al. compared changes in physiological and subjective ratings when different musical excerpts were performed in a laboratory session. Notably, those who had previously performed a Debussy piece had significantly lower HR (Kenny et al., 2013). This finding is consistent with one of the main findings of the present report, that experience with the same piece on stage correlated with lower HR from the first to the third live performance. In addition, we used a sum score – not an average score – for the error evaluation to in part control for the fact that the selected pieces were not comparable. An alternative and more homogeneous selection criterion for the choice of the evaluated pieces could be achieved if the measurements were performed, for example, during a performance competition were excerpts with similar difficulty are performed. Such a measurement situation has been deployed by others in the past to assess MPA in pianists (Yoshie et al., 2009). Within the context of sports, performing seminal work on stress arousal measurement during ski jumping, Kusserow et al., showed that HR significantly increased from training to qualification to Olympic competition (Kusserow et al., 2010). The HR values observed during competition were comparable to the values we observed here, confirming that the evaluative context of performance more than a specific set of tasks have the power to trigger MPA.

3.1.11. The number of errors

The number of errors decreased from the 1st to the 3rd performance without additional off-stage rehearsals. These results replicate the findings of our previous case report (Kusserow et al., 2012). While one musician stopped playing during one of the performances, all others performed without breakdowns. This confirms that performance is possible even under very stressful conditions and that the participants had most likely practiced enough to play by heart in front of an audience, with a comparable technical level. A possible limitation of our study is that we did not ask participants about their thoughts during execution. This information could provide clues to the reasons and nature of the errors they committed. While we avoided giving participants any instructions throughout the measurements, it is reasonable to assume that they instructed themselves in some way to cope with their anxiety. Recent work on so-called ironic errors in reactive motor performance under pressure has shown that the type of instruction can modulate such errors, at least in reactive motor tasks (Gorgulu et al., 2019) that are somewhat different to the kind of motor task performed here. In the domain of musical performance, Mornell and Wulf have shown that explicitly instructing performers to adopt an external attentional focus leads to significantly greater technical precision during performance under pressure (Mornell and Wulf, 2019). It is conceivable that a reduction in anxiety level allowed musicians to unconsciously shift from an internal to an external focus of attention from 1st to 3rd performance. Therefore, interventions to address MPA could include both elements: repeated live performances of the same musical excerpts along with explicit instructions to potentiate external foci of attention (Hildebrandt and Nübling, 2004; Mornell and Wulf, 2019). Future research with comparable study designs to the one used here could include a more in-depth error analysis to develop a set of appropriate instructions that could counteract unintentional errors even under anxiety conditions while performing.

3.2. Contributions

Our data can contribute to understand some aspects of MPA management. The causes of MPA can be multifactorial and diverse (Brodsky, 1996; DeCaro et al., 2011; Studer et al., 2011b; Kenny et al., 2014; Kenny and Ackermann, 2015; Haccoun et al., 2020; Papageorgi and Welch, 2020; Jane, 2022; Sokoli et al., 2022). Therefore, our data can only partially contribute to the management of MPA. In particular, the components related to the modulation of physiological parameters strongly associated with MPA may be affected by desensitization. For instance, practicing under stress is clearly beneficial for reducing HR (Oudejans and Pijpers, 2009, 2010; Kusserow et al., 2010, 2012). Among the causes of MPA, excessive physical arousal before or during performance was the second most frequently cited cause in previous reports, accounting for 78.3% of participants' responses (Kenny et al., 2014). Obviously, the reduction of sympathetic activity had a positive effect on the quality of the performance – as measured in our study by the smaller number of errors from the 1st to the 3rd performance – and the subjective evaluation of the situation – as measured by the lower VAS-MPA values and the greater calmness. Therefore, particular attention should be paid to sympathetic responses during performance in studies on MPA. This is also important because high sympathetic activation during training has been reported to lead to better performance in real-life situations (Oudejans and Pijpers, 2009) and should therefore be an important goal of any training for MPA management.

3.3. Future investigations

We have presented here data on the effects of repeated live performances of the same musical excerpts within a short time frame of about 4 h. However, multiple elements should also be considered when searching for appropriate training strategies to manage MPA. Therefore, several other training elements should be investigated in further research, and one of the tools to assess their effectiveness should consider over-time changes in HR. For instance, lack of general self-confidence was identified as a major source of MPA (Kenny et al., 2014), and our practical experience shows that building a personal stage choreography, including clapping, bowing or reverences (Hildebrandt and Nübling, 2004; Hildebrandt, 2009), contributes to greater confidence when performing. An alternative or complement to HR could be the use of HRV to assess changes induced by, for example, MPA interventions for self-regulation. However, their complexity and interpretation should not be underestimated, as there are several theories that make predictions about the role of vagal activity. In addition, there are limitations to measuring stress with HRV, and the relationships between subjective ratings and HRV are inconsistent and difficult to interpret, as are many of the numerous parameters that have been assessed with HRV. Nevertheless, studies of vagally mediated HRV are promising (Mosley and Laborde, 2022), and could also be performed as part of future investigations on MPA management techniques.

3.3.1. Psychological interventions: Positive psychology and cognitive behavioral therapy

Negative post-event rumination has been reported to promote performance anxiety (Nielsen et al., 2018; Guyon et al., 2020) even beyond the stage (Haccoun et al., 2020).

The use of Multi-component Positive Psychology interventions (MPPIs) in MPA could be considered. Randomized control trials have shown that they can have a positive effect on anxiety and stress, although more well-controlled data are needed (Hendriks et al., 2020).

The use of cognitive behavioral therapy (CBT), can consider multiple aspects involved in the causation of MPA, even in individuals who experience MPA but do not suffer, for example, from generalized anxiety disorder (GAD). This is particularly noteworthy because professional orchestral musicians consider 'pressure from self' to be the cause of their MPA (Kenny et al., 2014), and because it has recently been shown that musicians' MPA is strongly predicted by GAD – and not social anxiety disorder (SAD; Wiedemann et al., 2022). CBT has been shown to be particularly effective for treating GAD, to the same extent as medication (Otte, 2011) and with long-lasting effects (Bandelow et al., 2018). Again, a pre-to-post intervention evaluation of the efficacy of such psychological interventions by means of physiological and psychological tests and their correlation is needed. This appears feasible, as we have prototypically shown here for repeated live performances under pressure.

Thus, negative post-event ruminators may benefit from the use of explicit strategies elaborated with positive psychology and cognitive behavioral therapy and they should be also evaluated in relation to physiological reactions, pre- and post-interventions. In the same line of constructive interventions, the training of a constructively oriented attention focus needs similar evaluations (Brodsky, 1996; Hildebrandt and Nübling, 2004).

3.4. Conclusion

Stage training reduces both HR and restlessness during MPA. Successful public performances under higher HR than HR during rest periods remain possible. These results underscore the importance of practicing on stage to get used to it, not just practicing off stage. Musicians – especially students – might consider this type of training a necessary step towards better managing MPA. Such training can contribute to better live performances and prevent destructive mental attitudes and physical injuries from over-practicing. HR monitoring should be an integral part of evaluating the effectiveness of interventions to better manage physical activity and properly train performance at higher HR (i.e., high sympathetic activation), especially considering that wearable technology and devices such as wristwatches equipped with the necessary technology are readily available. Moreover, textile-integrated sensos could be also considered. The long-term effects of the kind of intervention presented here (i.e., over days, weeks and even months post intervention) remain to be investigated. Following our earlier report, we used three performances in 1 day here. Questions arise about how many consecutive performances and what time interval is the optimal training protocol to achieve and maintain acclimatization. Other questions relate to the use of HR data for training and how it should be presented and applied (e.g., on-site or during visualization). Still other questions are possible and need to be investigated.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the local Ethical Committee at ETH Zurich (EK 2010-N-57). The participants provided their written informed consent to participate in this study.

Author contributions

VC planned the study, collected and analyzed data, performed statistical calculations on all data, and wrote the manuscript. MK planned the study, collected and analyzed sensor data, critically reviewed the manuscript, and contributed to the discussion. OM collected audio and video data, analyzed subjective data, and critically reviewed the manuscript. HH planned the study, recruited participants, analyzed data, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1146405/full#supplementary-material

References

Aiken, C. A., and Becker, K. A. (2022). Utilizing an internal focus of attention during preparation and an external focus during execution may facilitate motor learning. *European J. Sport Sci.* 1–19.

Angelidis, A., Solis, E., Lautenbach, F., van der Does, W., and Putman, P. (2019). I'm going to fail! Acute cognitive performance anxiety increases threat-interference and impairs WM performance. *PLoS One* 14:e0210824. doi: 10.1371/journal.pone.0210824

Antonini Philippe, R., Cruder, C., Biasutti, M., and Crettaz von Roten, F. (2022). The Kenny music performance anxiety inventory-revised (K-MPAI-R): validation of the Italian version. *Psychol. Music.* 51, 565–578. doi: 10.1177/03057356221101430

Bandelow, B., Sagebiel, A., Belz, M., Görlich, Y., Michaelis, S., and Wedekind, D. (2018). Enduring effects of psychological treatments for anxiety disorders: meta-analysis of follow-up studies. *Br. J. Psychiatry* 212, 333–338. doi: 10.1192/bjp.2018.49

Baumeister, R. F. (1984). Choking under pressure: self-consciousness and paradoxical effects of incentives on skillful performance. *J. Pers. Soc. Psychol.* 46, 610–620. doi: 10.1037/0022-3514.46.3.610

Becker, K. A., Fairbrother, J. T., and Couvillion, K. F. (2020). The effects of attentional focus in the preparation and execution of a standing long jump. *Psychol. Res.* 84, 285–291.

Brodsky, W. (1996). Music performance anxiety reconceptualized: a critique of current research practices and findings. *Med. Probl. Perform. Art.* 11, 88–98.

Brodsky, W. (1999). Auffuhrungsangste bei Musikern als musikbezogenes Phanomen: Ein neues Konzept. *Musikphysologie und Musikermedzin* 6, 14–18.

DeCaro, M. S., Thomas, R. D., Albert, N. B., and Beilock, S. L. (2011). Choking under pressure: multiple routes to skill failure. *J. Exp. Psychol. Gen.* 140, 390–406. doi: 10.1037/a0023466

Doane, C. (1989). The development and testing of a program for the development of conductor aural error detection skills. *CBDNA J.* 6, 11–14.

Gomez, P., Nielsen, C., Studer, R. K., Hildebrandt, H., Klumb, P. L., Nater, U. M., et al. (2018). Prolonged performance-related neuroendocrine activation and perseverative cognition in low-and high-anxious university music students. *Psychoneuroendocrinology* 95, 18–27.

Gorgulu, R., Cooke, A., and Woodman, T. (2019). Anxiety and ironic errors of performance: task instruction matters. *J. Sport Exerc. Psychol.* 41, 82–95. doi: 10.1123/jsep.2018-0268

Guyon, A. J., Hildebrandt, H., Güsewell, A., Horsch, A., Nater, U. M., and Gomez, P. (2022). How audience and general music performance anxiety affect classical music students' flow experience: a close look at its dimensions. *Front. Psychol.* 13:959190. doi: 10.3389/fpsyg.2022.959190

Guyon, A. J., Studer, R. K., Hildebrandt, H., Horsch, A., Nater, U. M., and Gomez, P. (2020). Music performance anxiety from the challenge and threat perspective: psychophysiological and performance outcomes. *BMC psychology* 8, 1–13. doi: 10.1186/s40359-020-00448-8

Haccoun, Y. E., Hildebrandt, H., Klumb, P. L., Nater, U. M., and Gomez, P. (2020). Positive and negative post performance-related thoughts predict daily cortisol output in university music students. *Front. Psychol.* 11:585875. doi: 10.3389/fpsyg.2020.585875

Hamilton, P. S., and Tompkins, W. J. (1986). Quantitative investigation of QRS detection rules using the MIT/BIH arrhythmia database. *IEEE Trans. Biomed. Eng.* BME-33, 1157–1165. doi: 10.1109/TBME.1986.325695

Hendriks, T., Schotanus-Dijkstra, M., Hassankhan, A., De Jong, J., and Bohlmeijer, E. (2020). The efficacy of multi-component positive psychology interventions: a systematic review and meta-analysis of randomized controlled trials. *J. Happiness Stud.* 21, 357–390. doi: 10.1007/s10902-019-00082-1

Higuchi, T., Imanaka, K., and Hatayama, T. (2002). Freezing degrees of freedom under stress: kinematic evidence of constrained movement strategies. *Hum. Mov. Sci.* 21, 831–846. doi: 10.1016/S0167-9457(02)00174-4

Hildebrandt, H. (2009). *Teaching music physiology and motor learning processes at a university: Experience and evaluation*. Frankfurt: Peter Lang.

Hildebrandt, H. (2010). "Bühnenkompetenz erlernen. Das Psycho-physiologische Vorspiel- und Vorsingtraining an der Musikhochschule" in *Pragmatik der Gefühle*. eds. R. Egloff, J. Fehr and G. Folkers (Zurich: Chronos)

Hildebrandt, H., and Nübling, M. (2004). Providing further training in musicophysiology to instrumental teachers: do their professional and preprofessional students derive any benefit? *Med. Probl. Perform. Art.* 19, 62–69. doi: 10.21091/mppa.2004.2010

Hildebrandt, H., Nübling, M., and Candia, V. (2012). Increment of fatigue, depression, and stage fright during the first year of high-level education in music students. *Med. Probl. Perform. Art.* 27, 43–48. doi: 10.21091/mppa.2012.1008

Jane, W. J. (2022). Choking or excelling under pressure: evidence of the causal effect of audience size on performance. *Bull. Econ. Res.* 74, 329–357. doi: 10.1111/boer.12307

Johnson, C. M., and Geringer, J. M. (2007). Predicting music majors' overall ratings of wind band performances: Elements of music. *Bulletin. Council. Res. Music Educ.* 25–38.

Kenny, D. (2017). *Kenny music performance anxiety inventory - certified German translation*. doi: 10.13140/RG.2.2.22381.59367

Kenny, D., and Ackermann, B. (2015). Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. *Psychol. Music* 43, 43–60. doi: 10.1177/0305735613493953

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T., Fortune, J. M., and Ackermann, B. (2013). Predictors of music performance anxiety during skilled performance in tertiary flute players. *Psychol. Music* 41, 306–328. doi: 10.1177/0305735611425904

Kothgassner, O. D., Goreis, A., Bauda, I., Ziegenaus, A., Glenk, L. M., and Felnhofer, A. (2022). Virtual reality biofeedback interventions for treating anxiety. *Wiener klinische Wochenschrift*, 1–11.

Kothgassner, O. D., Goreis, A., Glenk, L. M., Kafka, J. X., Pfeffer, B., Beutl, L., et al. (2021). Habituation of salivary cortisol and cardiovascular reactivity to a repeated real-life and virtual reality Trier Social Stress Test. *Physiol. Behav.* 242:113618.

Kusserow, M., Amft, O., Gubelmann, H., and Tröster, G. (2010). Arousal pattern analysis of an Olympic champion in ski jumping. *Sports technology* 3, 192–203. doi: 10.1080/19346182.2011.564285

Kusserow, M., Candia, V., Amft, O., Hildebrandt, H., Folkers, G., and Troster, G. (2012). Monitoring stage fright outside the laboratory: an example in a professional musician using wearable sensors. *Med. Probl. Perform. Art.* 27, 21–30. doi: 10.21091/mppa.2012.1005

Mesagno, C., Harvey, J. T., and Janelle, C. M. (2012). Choking under pressure: the role of fear of negative evaluation. *Psychol. Sport Exerc.* 13, 60–68. doi: 10.1016/j.psychsport.2011.07.007

Mornell, A., and Wulf, G. (2019). Adopting an external focus of attention enhances musical performance. *J. Res. Music. Educ.* 66, 375–391. doi: 10.1177/0022429418801573

Mosley, E., and Laborde, S. (2022). A scoping review of heart rate variability in sport and exercise psychology. *Int. Rev. Sport Exerc. Psychol.*, 1–75. doi: 10.1080/1750984X.2022.2092884

Nielsen, C., Studer, R. K., Hildebrandt, H., Nater, U. M., Wild, P., Danuser, B., et al. (2018). The relationship between music performance anxiety, subjective performance quality and post-event rumination among music students. *Psychol. Music* 46, 136–152. doi: 10.1177/0305735617706539

Noteboom, J. T., Barnholt, K. R., and Enoka, R. M. (2001). Activation of the arousal response and impairment of performance increase with anxiety and stressor intensity. *J. Appl. Physiol.* 91, 2093–2101. doi: 10.1152/jappl.2001.91.5.2093

Otte, C. (2011). Cognitive behavioral therapy in anxiety disorders: current state of the evidence. *Dialogues Clin. Neurosci.* 13, 413–421. doi: 10.31887/DCNS.2011.13.4/cotte

Oudejans, R. R., and Pijpers, J. R. (2009). Training with anxiety has a positive effect on expert perceptual–motor performance under pressure. *Q. J. Exp. Psychol.* 62, 1631–1647. doi: 10.1080/17470210802557702

Oudejans, R. R., and Pijpers, J. R. (2010). Training with mild anxiety may prevent choking under higher levels of anxiety. *Psychol. Sport Exerc.* 11, 44–50. doi: 10.1016/j.psychsport.2009.05.002

Papageorgi, I., and Welch, G. F. (2020). "A bed of nails": professional musicians' accounts of the experience of performance anxiety from a phenomenological perspective. *Front. Psychol.* 11:605422. doi: 10.3389/fpsyg.2020.605422

Schmidt, R. F., Lang, F., and Brandes, R. (2019). *Physiologie des Menschen: mit Pathophysiologie*. Springer.

Schommer, N. C., Hellhammer, D. H., and Kirschbaum, C. (2003). Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psycho. Med.* 65, 450–460.

Sokoli, E., Hildebrandt, H., and Gomez, P. (2022). Classical music Students' pre-performance anxiety, catastrophizing, and bodily complaints vary by age, gender, and instrument and predict self-rated performance quality. *Front. Psychol.* 13:905680. doi: 10.3389/fpsyg.2022.905680

Steinmetz, A., Scheffer, I., Esmer, E., Delank, K., and Peroz, I. (2015). Frequency, severity and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany. *Clin. Rheum.* 34, 965–973.

Steyer, R., Schwenkmezger, P., Notz, P., and Eid, M. (1997). Der Mehrdimensionale Befindlichkeitsfragebogen [Online]. Göttingen, Berne, Toronto, Seatle: Hochgrefe.

Studer, R., Danuser, B., Hildebrandt, H., Arial, M., and Gomez, P. (2011a). Hyperventilation complaints in music performance anxiety among classical music students. *J. Psychosom. Res.* 70, 557–564. doi: 10.1016/j.jpsychores.2010.11.004

Studer, R. K., Danuser, B., Hildebrandt, H., Arial, M., Wild, P., and Gomez, P. (2012). Hyperventilation in anticipatory music performance anxiety. *Psychosom. Med.* 74, 773–782. doi: 10.1097/PSY.0b013e31825e3578

Studer, R. K., Danuser, B., Wild, P., Hildebrandt, H., and Gomez, P. (2014). Psychophysiological activation during preparation, performance, and recovery in high- and low-anxious music students. *Appl. Psychophysiol. Biofeedback* 39, 45–57. doi: 10.1007/s10484-014-9240-2

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011b). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Studer, R. K., Nielsen, C., Klumb, P. L., Hildebrandt, H., Nater, U. M., Wild, P., et al. (2019). The mediating role of mood in the relationship between perseverative cognition, sleep and subjective health complaints in music students. *Psychol. Health* 34, 754-770.

Trotman, G. P., Veldhuijzen van Zanten, J. J., Davies, J., Möller, C., Ginty, A. T., and Williams, S. E. (2019). Associations between heart rate, perceived heart rate, and anxiety during acute psychological stress. *Anxiety, Stress, & Coping* 32, 711–727. doi: 10.1080/10615806.2019.1648794

Waggoner, D. T. (2011). Effects of listening conditions, error types, and ensemble textures on error detection skills. *J. Res. Music Educ.* 59, 56–71.

Watson, D., and Friend, R. (1969). Measurement of social evaluative anxiety. *J. Consult. Clin. Psychol.* 33, 448–457. doi: 10.1037/h0027806

Wiedemann, A., Vogel, D., Voss, C., and Hoyer, J. (2022). How does music performance anxiety relate to other anxiety disorders? *Psychol. Music* 50, 204–217. doi: 10.1177/0305735620988600

Williamon, A., Aufegger, L., and Eiholzer, H. (2014). Simulating and stimulating performance: introducing distributed simulation to enhance musical learning and performance. *Front. Psychol.* 5:25. doi: 10.3389/fpsyg.2014.00025

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Yoshie, M., Kudo, K., and Ohtsuki, T. (2008). Effects of psychological stress on state anxiety, electromyographic activity, and arpeggio performance in pianists. *Med. Probl. Perform. Art.* 23, 120–132. doi: 10.21091/mppa.2008.3024

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The effects of anxiety on practice behaviors and performance quality in expert pianists

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Introduction: During their career, musicians need to undergo intense periods of training to master musical instruments and become accomplished artists. Dysfunctional practice behaviors and anxiety are often mentioned among the possible risk factors for playing-related injuries in musicians. However, the mechanism through which these might lead to the onset of these injuries is still unclear. The present study aims at overcoming this limitation by investigating the relationship between quantitative measurements of anxiety, practice behaviors and music performance quality.

Methods: The experiment consisted in monitoring practice behaviors in 30 pianists practicing a short musical task.

Results: Most self-report anxiety measurements were positively correlated with practice time, especially those collected right before the practice sessions. Similar correlations were identified between anxiety and the number of repetitions of the musical task. Physiological markers of anxiety were only weakly related to practice behaviors. Subsequent analyses showed that high levels of anxiety were associated with poor quality of music performances at baseline. Nevertheless, the interaction between participants' learning rate and anxiety measures showed no association with performance quality scores. Moreover, anxiety and performance quality co-developed during practice sessions, showing that pianists who improved their playing were also less anxious in the latter part of the experiment.

Discussion: These findings suggest that anxious musicians are likely at higher risk of developing playing-related injuries related to overuse and repetitive strains. Future directions and clinical implications are discussed.

KEYWORDS

practice behavior, anxiety, musical performance, professional musicians, playing-related injuries

1. Introduction

Musicians are highly exposed to the risk of developing playing-related injuries. These are related to both genetic and environmental factors. Specifically, dysfunctional practice behaviors such as excessive repetitions and over-practice, anxious traits and stressful working conditions are often mentioned among their possible risk factors (Ackermann et al., 2012, 2014). However, the mechanism through which these might lead to the onset of playing-related injuries is still poorly understood.

1.1. The effects of practice and the role of practice quality

During their career, musicians need to undergo intense periods of training to master musical instruments and become accomplished artists. Not every musician progresses at the same pace: some students may in fact advance faster than other learning peers, despite similar practicing time (Bonneville-Roussy and Bouffard, 2015), which may result in higher academic proficiency and professional accomplishments. Several factors influence the long path to expertise in music: the literature on talent and giftedness suggests that in order to excel as musician it is often necessary to have proper tuition, financial support as well as motivation and natural abilities (Preckel et al., 2020).

Several studies have emphasized the importance of deliberate practice as it explains approximately 21% of variance in performance quality in music (Macnamara et al., 2014). Ericsson et al. (1993) specify that only a certain type of practice leads to proper improvements: they use the term deliberate practice to define "goal directed practice aimed at improving, requiring effort, concentration, determination and proper tuition" (Bonneville-Roussy and Bouffard, 2015, p.688).

Inefficient practice strategies may not only delay progress but also have secondary effects: low effectiveness may result in prolonged practice sessions, in the attempt to overcome the lack of improvement. Overpractice and repetitive practice behaviors may cause muscular overuse and lead to motor fatigue, increasing the risk of playing-related musculoskeletal disorders (Ackermann et al., 2012), which affect approximately 43% of all professional musician (Zaza, 1998). Playing-related injuries often consist of painful and disabling conditions with detrimental effects on musical performance and musicians' career (Yoshimura and Chesky, 2009; Kenny and Ackermann, 2015).

Moreover, the literature suggests that long and demanding practice routines may have important effects on brain structures, as they may trigger dysfunctional plasticity and thus contribute to the onset of movement disorders as in the case of musicians' focal dystonia (Altenmüller and Jabusch, 2009). This framework is further supported by evidence from animal models where symptoms and neural conditions comparable to focal hand dystonia have been successfully induced in primates by means of massed repetitions (Byl et al., 1997; Byl, 2007).

1.2. Anxiety in musicians

Music performance anxiety is often mentioned among the risk factors of playing-related injuries in music and it affects between 16.5 and 60% of all musicians (Fernholz et al., 2019). It is a multidimensional construct and it manifests itself on both cognitive and somatic dimensions (Miller and Chesky, 2004; Papageorgi et al., 2007; Papageorgi, 2022), including physiological symptoms and behavioral changes as increased heart rate, reduced heart rate variability (LeBlanc et al., 1997), shaky and numb fingers as well as arm and neck stiffness. It can also involve psychological reactions as exaggerated fear and apprehension as well as cognitive impairments as lack of concentration and memory slips (Kenny, 2011).

Anxiety is considered a comorbidity of performance-related musculoskeletal disorders (Ackermann et al., 2012; Kenny and Ackermann, 2015). For instance, Ranelli et al. (2015) showed significant associations between music performance anxiety and playing-related pain in children, during early stages of learning a musical instrument. Moreover, trait anxiety is listed among the psychological trigger and risk factors of musicians' focal dystonia: Altenmüller and Jabusch (2009) showed that musicians affected by this movement disorder have higher levels of anxiety, which might lead to repetitive practice behaviors and stress-induced consolidation of dystonic movements. The literature suggests that a common response to anxiety may include ritualistic behaviors, rigidity as well as repetitive motor patterns (Lang et al., 2015): anxious individuals seem to frequently perform familiar tasks in order to reestablish a feeling of order and control. Sporn et al. (2020) supported this idea, showing that state anxiety may reduce motor exploration during the acquisition of new motor tasks, thus affecting the quality of learning. However, the consistency of these findings in the context of musical practice is still to be assessed.

While the effect of anxiety on performance quality is rather controversial (Brotons, 1994; Cohen and Bodner, 2019), the relationship between anxiety and practice behaviors in music remains almost undocumented. A pioneering study by McPherson and McCormick (1999) analyzed practice behaviors, anxiety and other psychological traits in 190 pianists preparing for performance examinations in music academies. Their results indicated a significant positive association between pre-performance anxiety and the amount of weekly practice in the month preceding the examinations. Moreover, musicians who incorporated more technical exercises in their practice routines exhibited higher levels of music performance anxiety. Nonetheless, the study did not clarify why anxiety might increase the amount of practice nor did it examine the relationship between anxiety and practice behaviors.

1.3. Aim of the study

The present study aims at investigating the relationship between anxiety, practice behaviors, and performance quality by monitoring 30 pianists practicing a short musical excerpt. Specifically, it investigates whether musicians who show high levels of anxiety practice longer, employ more repetitions and improve at a slower pace than their less anxious peers.

2. Methods

2.1. Design

The study involved quantitative measurements of anxiety, practice behaviors, and performance quality with the aim at investigating the relationship between the three variables. The experiment consisted in monitoring practice behaviors in healthy young pianists while practicing a short musical task: testing healthy musicians allowed to avoid biases related to playing-related injuries, their time course, and treatments. To measure improvements in performance quality, run-throughs of the musical task were recorded at baseline and acquisition, before and after the practice sessions. During the experiment, anxiety was assessed by means of self-report measurements as well as physiological data. The testing procedure was inspired and freely adapted from a previous study by Bangert et al. (2014).

The Central Ethics Committee at Leibniz University Hannover approved the present study.

2.2. Participants

Participation was open to student pianists from the University of Music, Drama, and Media in Hannover, Germany. Participants were clinically healthy and did not report any pain or injury at the time of the experiment. Moreover, they did not have any previous experience with the musical task used in the experiment, nor with the musical piece on which it was based. 33 musicians took part in the experiment: three participants were excluded from the study for not following the instructions provided by the experimenter.

The resulting sample ($N = 30$) had a mean age of 24.13 years (SD = 3.92), 60% were females and 40% were males. 43.3% of the sample were undergraduate students while the remaining 56.7% were enrolled in postgraduate study courses, as Master of Music or Konzertexamen. Further information is reported in Table 1. All participants were above 18 years of age, and they received a compensation of 50€ for their collaboration with the investigation.

2.3. Materials and instruments

2.3.1. Baseline measurements

At the beginning of the experiment, participants completed a questionnaire investigating their demographics, the current degree program and the amount of lifetime practice, measured in hours (see Table 1). The survey also included the Spielberger State–Trait Anxiety Inventory (STAI, Spielberger, 1989) as well as six items aimed at investigating participants' history of playing-related injuries, to assess their eligibility for participating in the study.

2.3.2. Piano performance

The musical task used in the experiment was inspired by Scriabin's Sonata op.53, bar 85, and consisted of multiple bidirectional octave leaps in a simple rhythmic structure performed with their right hand only, as shown in Figure 1. During baseline and acquisition assessment phases the excerpt was repeated five times: participants were allowed to take breaks of few seconds (M = 2.21 s, SD = 1.13 s) in between repetitions. Both tests were assisted by a metronome, set at 90 beats per minute (bpm). Piano performances were recorded using a CASIO PX-730 electric piano, which was connected to a MOTU 828mk3 soundcard *via* MIDI interface.

Performance quality was assessed based on four parameters: *wrong notes, missed notes, rhythmic accuracy,* and *loudness homogeneity. Wrong notes* measured the number of notes extraneous to the excerpt while *missed notes* represent those that were not played by the participant. Given the homorhythmic texture and regularity in dynamics of the musical task, *rhythmic accuracy* and *loudness homogeneity* were assessed as standard deviations of inter-onset intervals and MIDI keystroke velocity, respectively. The four parameters were computed across all five repetitions of the musical task performed during each assessment phase. Baseline and acquisition performances were evaluated separately for each participant.

2.3.3. Practice behaviors

Practice behaviors during the practice session were analyzed according to the following parameters: *practice time,* measuring the duration of individual practice sessions in minutes, *keystrokes on target*, defined as the total number of piano keystrokes on pitches belonging to the musical task (see Figure 1), and *total keystrokes,* indicating the total number of keystrokes during the practice session irrespective of the pitch.

2.3.4. Anxiety measures

During the experiment, anxiety was assessed by means of self-report measurements as well as physiological data. State and trait anxiety were measured through the Spielberger State–Trait Anxiety Inventory (STAI, Spielberger, 1989): the measurement instrument consists of 40 items in total, rated on a four-point Likert scale of agreement, aimed at assessing state anxiety (STAI-S, 20 items) and trait anxiety (STAI-T, 20 items) separately. In addition to this, Visual Analogue Scales of Anxiety (VASA) were implemented to monitor participants' state anxiety throughout the experimental procedure: they consisted in a single item investigating how anxious and tense participants felt right before and after each performance assessment phase. VASA was rated on an 11-point ordinal scale, with values ranging between 0, "not at all," and 10, "very much." As shown in Figure 2, VASA 1 and VASA 3 measured pre-performance anxiety, before baseline and acquisition assessment procedures, respectively. VASA 2 and VASA 4 quantified post-performance anxiety after the two tests. The placement, labeling and descriptive statistics of the anxiety measurements used in the study is reported in Figure 2.

Participants' heart activity was monitored through electrocardiograms (ECG). The resulting data were used to compute mean Heart Rate (*HR*) and the Coefficient of Variation of RR intervals (*CVRR*; *see* Sporn et al., 2020; Hein et al., 2021), as explained in the section Data processing. The recordings were performed using HEI ECG-AMP04 sensors placed in a three-lead ECG configuration and connected to a CED Micro1401-3 data acquisition unit. ECG signal was recorded by Signal 5.12 data acquisition software, sampling data

TABLE 1 Descriptive statistics for the variables age, age at which participants started playing the piano, and lifetime practice.

	Mean	SD
Age	24.13	3.92
Age at which participants started playing piano	6.50	3.63
Lifetime practice (hours)	17,723	10,273

$N = 30$.

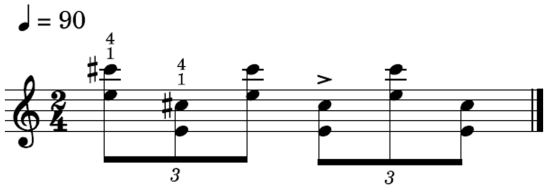

FIGURE 1
Musical task inspired by Scriabin, Sonata op.53.

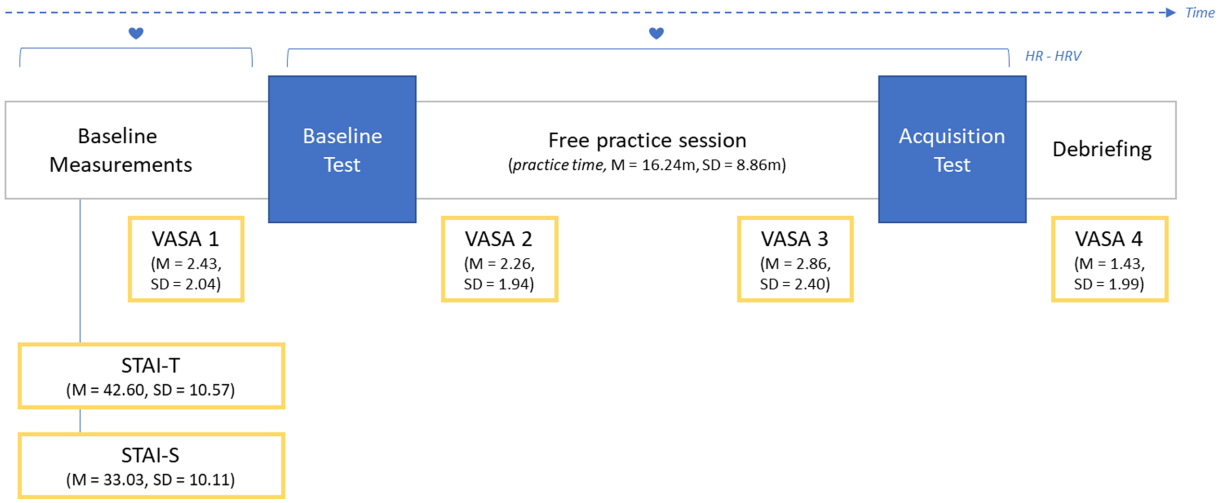

FIGURE 2
Timeline of the experimental procedure and descriptive statistics for anxiety measures and practice time. Anxiety was assessed by the Spielberger State–Trait Anxiety Inventory (STAI), measuring Trait (STAI-T) and State anxiety (STAI-S), Visual Analogue Scales for Anxiety (VASA) at four timepoints as well as continuous electrocardiogram.

at 1000 Hz. ECG and piano performance data were synchronized by means of analogue pulse signals, allowing a synchronization accuracy greater than one millisecond per minute of recording. MIDI data and pulse signals were recorded through Reaper v6.36 digital audio workstation, sampling data at 44,100 Hz and 32 bits.

2.4. Testing procedure

Figure 2 represents the timeline of the experimental procedure. The experiment took place in a quiet room of approximately 9 m^2. At their arrival, participants filled out a questionnaire investigating their musical background, history of playing-related injuries as well as state and trait anxiety (STAI-S and STAI-T). Subsequently, the experimenter applied the ECG electrodes on participants' chest and invited them to freely warm-up on the MIDI piano used for the test, to familiarize with the musical instrument. After warm-up, the Principal Investigator (PI) explained the experimental procedure: participants were asked to freely practice a short musical task. Their goal was to play it as accurately as possible in terms of wrong and missed notes, rhythmical precision, and loudness regularity. No time constraints were imposed: participants were allowed to practice the musical excerpt as much as they wanted, using the practice strategies they preferred. During the practice session, the PI left the experiment room to reproduce conditions comparable with solitary practice. Participants were instructed to call back the researcher at the end of their practice session *via* phone.

Performance quality was assessed at baseline and acquisition, before and after the practice sessions, and each test consisted of five repetitions of the musical task, assisted by a metronome, set at 90 bpm. Participants were not allowed to practice the musical excerpt before the baseline performance quality assessment. However, they could analyze its notation and listen to it through a dedicated audio recording. To induce anxiety, participants were informed at the beginning of the experiment that their performances were going to be video recorded and rated by three professors of music at the local university. During the entire experiment, MIDI and ECG recordings were used to monitor participants' behavior and heart activity, respectively.

Note that the testing procedure here reported is part of a longer set of measurements and tests whose results will be described in future reports.

2.5. Data processing

Electrocardiogram signal was visually inspected to manually reject artifacts. Subsequently, a 30 Hz low-pass filter was applied, and R peaks were identified from QRS complexes using the findpeaks function from the R-package pracma (Borchers, 2022). The R-package RHRV (Rodriguez-Linares et al., 2022) allowed to additionally filter the resulting data by rejecting datapoints indicating unacceptable physiological values (i.e., outliers with HR < 25 bpm and HR > 200 bpm). Finally, the same R-package was used to interpolate data at 4 Hz. Thus, mean Heart Rate (*HR*) and the Coefficient of Variation of RR intervals (*CVRR*; *see* Sporn et al., 2020; Hein et al., 2021) were computed from the pre-processed data. To quantify increases or decreases in HR during the experiment, linear regression models were used to linearly predict HR by time of the measurement for each participant: thus, individual slope coefficients (*slope HR*) were extracted from regression models and used for the analyses. All physiological parameters were measured during practice sessions and performance evaluation phases.

MIDI data were analyzed through a computerized assessment procedure coded in R-language. Detailed information about the four performance quality parameters is reported in Appendix 1.

Subsequently, a principal component analysis procedure was performed with the R-package *lavaan* (Rosseel et al., 2022) to obtain an aggregate measure of performance quality, referred to as *performance quality* scores: three of four performance quality

parameters loaded adequately on a single factor (eigenvalue = 1.78), with factor loading ranging from 0.58 to 0.86. *Rhythmic accuracy* did not load sufficiently well on the latent variable probably due to ceiling effects in the measurement (see Appendix 1). Therefore, it was discarded from the analyses. Note that the resulting performance quality scale is an inverted scale: low *performance quality* scores correspond to high performance quality levels and vice versa. Finally, MIDI recordings were used to compute the variable *time*, which indicates at what timepoint in the experiment each performance was recorded, taking individual baseline performances as a reference, when *time* = 0.

2.6. Data analyses

All participants completed the experiment in its entirety and no missing data was produced. Correlation matrices were used to investigate the relationship between anxiety and practice behaviors, considering both self-report and physiological measures of anxiety as well as the practice behaviors descriptors mentioned in the previous paragraphs. As shown in Appendix 2, no significant differences in anxiety measures were found between female and male pianists ($p > 0.05$). Therefore, *gender* was not considered in the analyses.

The effect of anxiety and *time* on *performance quality* was assessed *via* Bayesian mixed effects regression models for repeated measures analyses. The models entered baseline and acquisition *performance quality* scores as criterion, *time* and anxiety measures as fixed effects and random intercepts per *performer* with random slopes per *time* as random effects. Note that baseline *performance quality* scores corresponded to *time* = 0 (for further information, see the Data processing section). Therefore, the main effects of stationary regressors (i.e., anxiety measures) described their relationship with baseline *performance quality* scores. The main effect of *time* quantified participants' learning rate, namely the average improvement in performance quality per minute of practice. Interactions between *time* and anxiety measures assessed differences in learning rate related to different anxiety levels. The analyses were run considering all the anxiety measures mentioned in the previous paragraphs as predictors: only the most relevant findings are reported in the present manuscript.

In this study, Bayesian effect estimates are reported along with 95% Credible Intervals (CI) in squared brackets. Thus, if this interval does not contain zero, the regressors are assumed to exert a (positive or negative) effect on the dependent variable with a probability of at least 95% (Hespanhol et al., 2019).

Latent change score models were modeled *via* the R-package *lavaan* (Rosseel et al., 2022) and used to analyze the relationship between self-reported anxiety, performance quality, and the development of these parameters during the experiment. The model measured changes in performance quality, pre-performance anxiety (VASA 1 and VASA 3) and post-performance anxiety (VASA 2 and VASA 4) due to practice and their covariance. Subsequently, it investigated correlations and cross-correlations between change scores and baseline values. The model was run under maximum likelihood estimation and its fit was evaluated in terms of χ^2, CFI, TFI, RFI, and SRMR values. RMSEA were not considered in the analyses, due to their limited validity in models with small degrees of freedom and sample sizes (Kenny et al., 2015). For a comprehensive overview of latent change score models, see Kievit et al. (2018).

All statistical analyses were conducted using the software RStudio (RStudio Team, 2021).

3. Results

3.1. The relationship between anxiety and practice behaviors

As shown in Table 2, *practice time*, *keystrokes on target*, and *total keystrokes* were positively correlated with most self-report anxiety measures, particularly with VASA 1 and VASA 2, at $p < 0.05$. Physiological markers of anxiety were only weakly and non-significantly correlated to practice behaviors parameters with the only exception of *mean HR*, which was positively correlated with *total keystrokes*, $r(28) = 0.395$, $p = 0.03$.

Thus, high levels of anxiety immediately before and after the baseline assessment procedure were associated with longer practice sessions and more repetitions.

3.2. The effect of anxiety and time on performance quality

Bayesian mixed effects regression models were run to investigate the effect of anxiety measures and *time* on performance quality scores during the experiment. All anxiety measurers were standardized across participants. Table 3 report the summary of the final models, where performance quality scores were predicted by either VASA 1 (model 1) or VASA 2 (model 2). *Time*, VASA 1, and VASA 2 had meaningful main effects on performance quality scores, but there were not relevant interactions between *time* and anxiety measures. These results did not generalize to the other anxiety variables included in the study, probably due to their lower temporal specificity and relevance. The two models reported in Table 3 explained between 43 and 50% of the variance in *performance quality* scores. Nevertheless, we prefer not to further comment on R^2 values, as their interpretation is quite controversial (i.e., Ozili, 2022), nor is a comparison between the two models reported in Table 3 meaningful, as they consider participants' state anxiety measured at two distinct timepoints.

TABLE 2 Correlations between anxiety measures and practice behavior descriptors.

	Practice time	Total keystrokes	Keystrokes on target
STAI-T	0.224	0.352	0.180
STAI-S	0.216	0.362*	0.234
VASA 1	0.408*	0.470*	0.295
VASA 2	0.472*	0.438*	0.379*
VASA 3	0.219	0.191	0.236
VASA 4	0.062	0.051	0.076
mean HR	0.310	0.395*	0.314
CVRR	−0.095	−0.199	−0.114
slope HR	−0.195	−0.209	−0.199

$N = 30$; *correlations are significant at $p < 0.05$. The table reports Pearson's r coefficients.

TABLE 3 The effect of state anxiety (VASA 1 and VASA 2) and time on performance quality scores.

	Model 1	Model 2
Fixed Effects	Estimate [95% CI]	Estimate [95% CI]
Intercept	0.40 [0.10, 0.72]	0.42 [0.14, 0.73]
Time	−0.05 [−0.08, −0.03]	−0.05 [−0.08, −0.03]
VASA 1[a]	0.33 [0.01, 0.67]	–
Time: VASA 1[a]	0.00 [−0.03, 0.02]	–
VASA 2[a]	–	0.48 [0.20, 0.76]
Time: VASA 2[a]	–	−0.00 [−0.03, 0.02]
Random Effects		
Performer:		
Intercept	0.42 [0.23, 0.59]	0.40 [0.23, 0.57]
Time	0.02 [0.00, 0.03]	0.02 [0.00, 0.03]
cor(Intercept, Time)	−0.06 [−0.73, 0.68]	−0.13 [−0.76, 0.60]
residuals	0.72 [0.53, 0.94]	0.69 [0.51, 0.89]
Coefficients of determination		
Conditional R^2	0.43 [0.26, 0.60]	0.50 [0.35, 0.66]
Marginal R^2	0.31 [0.15, 0.44]	0.39 [0.24, 0.51]

$N = 30$; [a]VASA 1 and VASA 2 were standardized across participants. The table reports fixed and random effects followed by 95% Credible Intervals (CI) in square brackets []. Performance quality scores were predicted by either VASA 1 (model 1) or VASA 2 (model2). Time quantified participants' rate of learning, namely the average improvement in performance quality per minute of practice. Interactions between time and anxiety measures assessed differences in learning rate related to different anxiety levels. For further information about the model, see the dedicated Data analyses section.

In summary, high levels of anxiety right before and after the baseline performance assessment were associated with poor *performance quality* at baseline. Nevertheless, the interaction between learning rate (*time*) and anxiety measures showed no association with *performance quality* scores.

3.3. Co-development of anxiety and performance quality measures

Figure 3 represents the latent change score model which was used to investigate the development of performance quality as well as pre-and post-performance anxiety during the experiment. The model showed good fit indices [$\chi^2(1, 21) = 0.129$, $p > 0.05$, CFI = 1.000, TLI = 1.000, RFI = 0.972, SRMR = 0.017] and indicated a significant positive correlation between pre-and post-performance anxiety change scores, $r = 0.572$, $p = 0.006$. Improvements in *performance quality* scores were moderately correlated with post-performance anxiety change scores only, $r = 0.494$, $p = 0.014$.

Moreover, two significant correlations between baseline scores and one cross-correlation between baseline and change scores were identified, evidencing the close relationship between anxiety and performance measures: VASA 2 was positively correlated with VASA 1, $r = 0.562$, $p = 0.007$, and baseline performance, $r = 0.483$, $p = 0.017$. Post-performance anxiety change scores were negatively related to baseline performance, $r = -0.454$, $p = 0.023$. Thus, performance quality scores and anxiety measurements seemed highly related and developed within a complex structure of mutual influences. For further information, see Appendix 3.

4. Discussion

The present study aimed at investigating the relationship between anxiety and practice behaviors in a sample of student pianists practicing a short musical task inspired by the piano literature. Specifically, it addressed the question whether musicians who show high levels of anxiety practice longer, employ more repetitions and improve at a lower rate than their colleagues.

4.1. Summary of results

The results indicated that most self-report anxiety measurements were positively correlated with practice time, especially those collected right before the practice sessions (see Table 2). Similar correlations were identified between anxiety and the number of repetitions of the musical task. Physiological markers of anxiety were only weakly related to practice behaviors' descriptors except for mean heart rate, which was significantly and positively correlated with the total number of keystrokes recorded during the practice sessions. Subsequent analyses showed that anxiety was associated with poor performance quality. Nevertheless, the interaction between participants' learning rate and anxiety measures showed no association with performance quality scores. Finally, anxiety and performance quality co-developed during the practice sessions, showing that pianists who improved their playing were also less anxious in the latter part of the experiment.

4.2. Anxiety, performance, and practice

In the present study, state anxiety was associated with longer practice sessions and repetitive practice behaviors, probably due to its negative effects on performance quality, in line with the literature (McPherson and McCormick, 1999; Yoshie et al., 2009a,b). These findings are important as they support the hypothesis that anxious musicians are at higher risk of developing occupational diseases as a result of overuse and repetitive strain (Altenmüller et al., 2015; Kenny and Ackermann, 2015).

Pre-and post-performance anxiety were closely related to piano performance, as they seem to be an emotional anticipation and response to poor performance quality. The effect of anxiety on performance quality is controversial and findings in the literature are rather inconsistent (Brotons, 1994; Ioannou et al., 2016; Cohen and Bodner, 2019). This might be explained by two methodological issues here avoided: first, the present study evaluated performance quality through an objective computerized assessment procedure, avoiding human judgments and their low reliability (Thompson and Williamon, 2003; Passarotto et al., in press). Furthermore, anxiety was measured at multiple time points and by different approaches, investigating both participants' subjective anxiety and physiological response throughout the experiment. This allowed to account for the high temporal variability in anxiety measurements (Rossi and Pourtois, 2012). Less reliable and

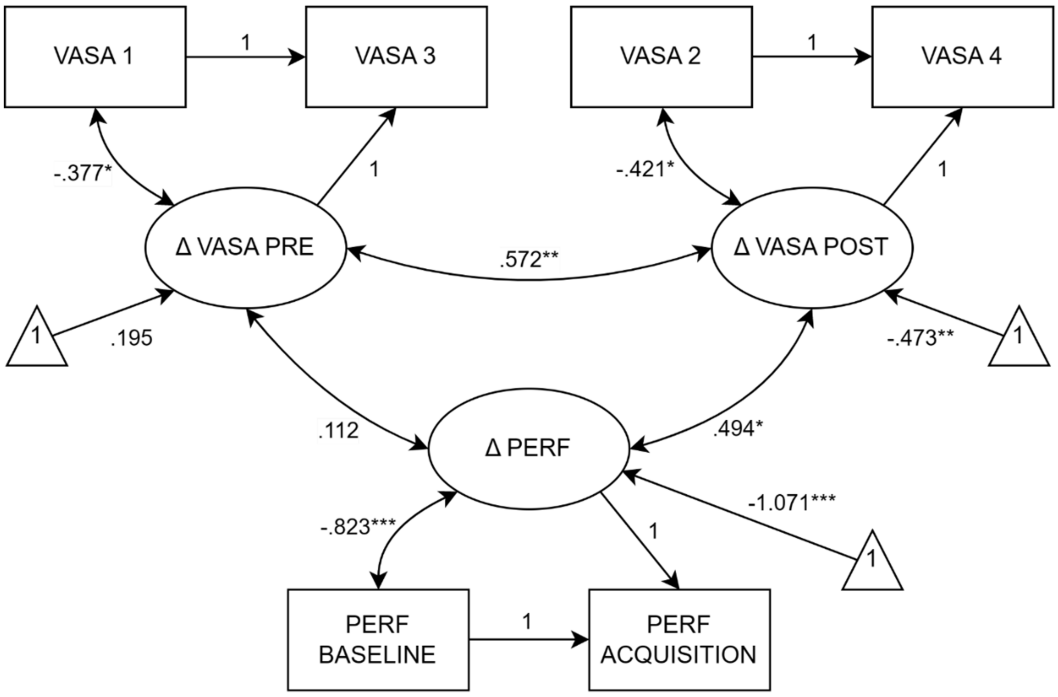

FIGURE 3
Co-development of anxiety and performance quality measures. *N* =30; *covariances are significant at p <0.05; **covariances are significant at p <0.01; ***covariances are significant at p <0.001. PERF, *performance quality*; VASA, visual analogue scales of anxiety. Latent change score model: only the most relevant covariances are reported. For further information, see the Data analyses section and Appendix 3.

less time-specific measurements (i.e., assessing only trait anxiety) might reduce the sensitivity of the analyses and lead to different results.

A plausible explanation for the relationship and co-development of anxiety and performance quality comes from the self-efficacy theory (Bandura, 1997): previous findings suggest that musicians who believe they have the necessary resources to achieve their goals are less anxious and perform better than their colleagues (McPherson and McCormick, 2006; González et al., 2018). In the short timeframe considered in this study, repetitive behaviors and improvements might have helped participants to increase their self-confidence while reducing anxiety. Thus, participants who were more anxious at the beginning of the practice session performed poorly at baseline and needed more time and repetitions to achieve a satisfactory performance quality. Nevertheless, the present study did not include any measure of self-efficacy and further studies are needed to verify this hypothesis.

4.3. Limitations

The present study comes with several limitations. First, it was conducted on a small sample of piano students and the findings might not generalize to other musical instruments or levels of expertise. Moreover, participants practiced a very short musical excerpt only few seconds in length which might not be representative of longer and more articulated musical structures.

The association between anxiety and repetitive practice behaviors here reported was identified on a practice task with a rather repetitive musical structure. This might have discouraged participants from showing greater variability in practice strategies, influencing the outcome of the analyses. Furthermore, the length of the experiment was often too short to analyze ECG signals appropriately by means of more informative approaches (i.e., spectral analysis). Anxiety was measured *via* well-established self-report measurement instruments which, however, were not specifically designed for musicians. The study investigated the effect of anxiety on performance and practice only at the early stages of learning a new musical excerpt which might not apply to later learning phases and highly trained repertoires. Finally, the relationship between anxiety and performance quality was investigated without considering the contribution of other covariates related to motor learning as perceptual and cognitive abilities (Anderson et al., 2021) as well as biomechanical characteristics of pianists' hands (Yoshimura et al., 2006; Yoshimura and Chesky, 2009).

4.4. Future development

The experimental procedure here implemented seems well suited for research projects investigating motor learning and practice behaviors in music, as already demonstrated by its original authors (Bangert et al., 2014). Testing healthy musicians allowed to avoid biases related to playing-related injuries, their time course and treatment. Nevertheless, future studies should assess the consistency of the present findings in different cohorts of musicians, especially in samples of musicians suffering from overuse and repetitive strain injuries. They could also evaluate the effectiveness of interventions aimed at reducing performance anxiety in terms of performance quality, practice time and practice behaviors. Finally, future studies might investigate the effect of

anxiety on retention of knowledge and memory consolidation in music, implementing longitudinal study designs.

5. Conclusion

In conclusion, this is the first study to systematically investigate the process through which anxiety interacts with practice behaviors: it provided a plausible and rational framework explaining the role of anxiety and practice behaviors in triggering playing-related injuries in musicians, for which they are rightfully considered risk factors. The results here reported highlight the importance of training protocols specifically aimed at improving practice effectiveness and reducing music performance anxiety, therefore preventing playing-related injuries in musicians.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Central Ethics Committee at Leibniz University Hannover. The patients/participants provided their written informed consent to participate in this study.

Author contributions

EP and EA contributed to conception and design of the study. EP collected the data. EP and FW performed the statistical analysis. EP wrote the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1152900/full#supplementary-material

References

Ackermann, B., Driscoll, T., and Kenny, D. T. (2012). Musculoskeletal pain and injury in professional orchestral musicians in Australia. *Med. Probl. Perform. Art.* 27, 181–187. doi: 10.21091/mppa.2012.4034

Ackermann, B. J., Kenny, D. T., O'Brien, I., and Driscoll, T. R. (2014). Sound Practiceâ "improving occupational health and safety for professional orchestral musicians in Australia". *Front. Psychol.* 5:973. doi: 10.3389/fpsyg.2014.00973

Altenmüller, E., Ioannou, C. I., and Lee, A. (2015). "Chapter 5-Apollo's curse: neurological causes of motor impairments in musicians," in *Progress in Brain Research*. eds. E. Altenmüller, S. Finger and F. Boller (Elsevier), 217, 89–106.

Altenmüller, E., and Jabusch, H.-C. (2009). Focal hand dystonia in musicians: phenomenology, etiology, and psychological trigger factors. *J. Hand Ther.* 22, 144–155. doi: 10.1016/j.jht.2008.11.007

Anderson, D. I., Lohse, K. R., Lopes, T. C. V., and Williams, A. M. (2021). Individual differences in motor skill learning: past, present and future. *Hum. Mov. Sci.* 78:102818. doi: 10.1016/j.humov.2021.102818

Bandura, A. (1997). *Self-efficacy: The exercise of control* W H Freeman/Times Books/Henry Holt & Co.

Bangert, M., Wiedemann, A., and Jabusch, H.-C. (2014). Effects of variability of practice in music: a pilot study on fast goal-directed movements in pianists. *Front. Hum. Neurosci.* 8:598. doi: 10.3389/fnhum.2014.00598

Bonneville-Roussy, A., and Bouffard, T. (2015). When quantity is not enough: disentangling the roles of practice time, self-regulation and deliberate practice in musical achievement. *Psychol. Music* 43, 686–704. doi: 10.1177/0305735614534910

Borchers, H. W. (2022). Pracma: Practical numerical math functions (2.4.2). Available at: https://CRAN.R-project.org/package=pracma

Brotons, M. (1994). Effects of performing conditions on music performance anxiety and performance Quality1. *J. Music. Ther.* 31, 63–81. doi: 10.1093/jmt/31.1.63

Byl, N. N. (2007). Learning-based animal models: task-specific focal hand dystonia. *ILAR J.* 48, 411–431. doi: 10.1093/ilar.48.4.411

Byl, N. N., Merzenich, M. M., Cheung, S., Bedenbaugh, P., Nagarajan, S. S., and Jenkins, W. M. (1997). A primate model for studying focal dystonia and repetitive strain injury: effects on the primary somatosensory cortex. *Phys. Ther.* 77, 269–284. doi: 10.1093/ptj/77.3.269

Cohen, S., and Bodner, E. (2019). Music performance skills: a two-pronged approach – facilitating optimal music performance and reducing music performance anxiety. *Psychol. Music* 47, 521–538. doi: 10.1177/0305735618765349

Ericsson, K. A., Krampe, R. T., and Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychol. Rev.* 100, 363–406. doi: 10.1037/0033-295X.100.3.363

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/S0033291719001910

González, A., Blanco-Piñeiro, P., and Díaz-Pereira, M. P. (2018). Music performance anxiety: exploring structural relations with self-efficacy, boost, and self-rated performance. *Psychol. Music* 46, 831–847. doi: 10.1177/0305735617727822

Hein, T. P., de Fockert, J., and Ruiz, M. H. (2021). State anxiety biases estimates of uncertainty and impairs reward learning in volatile environments. *NeuroImage* 224:117424. doi: 10.1016/j.neuroimage.2020.117424

Hespanhol, L., Vallio, C. S., Costa, L. M., and Saragiotto, B. T. (2019). Understanding and interpreting confidence and credible intervals around effect estimates. *Braz. J. Phys. Ther.* 23, 290–301. doi: 10.1016/j.bjpt.2018.12.006

Ioannou, C. I., Furuya, S., and Altenmüller, E. (2016). The impact of stress on motor performance in skilled musicians suffering from focal dystonia: physiological and psychological characteristics. *Neuropsychologia* 85, 226–236. doi: 10.1016/j.neuropsychologia.2016.03.029

Kenny, D. (2011). "Defining music performance anxiety," in *The Psychology of Music Performance Anxiety*. ed. D. Kenny (Oxford University Press).

Kenny, D., and Ackermann, B. (2015). Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. *Psychol. Music* 43, 43–60. doi: 10.1177/0305735613493953

Kenny, D. A., Kaniskan, B., and McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociol. Methods Res.* 44, 486–507. doi: 10.1177/0049124114543236

Kievit, R. A., Brandmaier, A. M., Ziegler, G., van Harmelen, A.-L., de Mooij, S. M. M., Moutoussis, M., et al. (2018). Developmental cognitive neuroscience using latent change

score models: a tutorial and applications. *Dev. Cogn. Neurosci.* 33, 99–117. doi: 10.1016/j.dcn.2017.11.007

Lang, M., Krátký, J., Shaver, J. H., Jerotijević, D., and Xygalatas, D. (2015). Effects of anxiety on spontaneous ritualized behavior. *Curr. Biol.* 25, 1892–1897. doi: 10.1016/j.cub.2015.05.049

LeBlanc, A., Jin, Y. C., Obert, M., and Siivola, C. (1997). Effect of audience on music performance anxiety. *J. Res. Music. Educ.* 45, 480–496. doi: 10.2307/3345541

Macnamara, B. N., Hambrick, D. Z., and Oswald, F. L. (2014). Deliberate practice and performance in music, games, sports, education, and professions: a meta-analysis. *Psychol. Sci.* 25, 1608–1618. doi: 10.1177/0956797614535810

McPherson, G. E., and McCormick, J. (1999). Motivational and self-regulated learning components of musical practice. *Bull. Counc. Res. Music. Educ.* 141, 98–102.

McPherson, G. E., and McCormick, J. (2006). Self-efficacy and music performance. *Psychol. Music* 34, 322–336. doi: 10.1177/0305735606064841

Miller, S. R., and Chesky, K. (2004). The multidimensional anxiety theory: an assessment of and relationships between intensity and direction of cognitive anxiety, somatic anxiety, and self-confidence over multiple performance requirements among college music majors. *Med. Probl. Perform. Art.* 19, 12–20. doi: 10.21091/mppa.2004.1003

Ozili, P. K. (2022). *The acceptable R-square in empirical modelling for social science research* (SSRN Scholarly Paper No. 4128165).

Papageorgi, I. (2022). Prevalence and predictors of music performance anxiety in adolescent learners: contributions of individual, task-related and environmental factors. *Music. Sci.* 26, 101–122. doi: 10.1177/1029864920923128

Papageorgi, I., Hallam, S., and Welch, G. F. (2007). A conceptual framework for understanding musical performance anxiety. *Res. Stud. Music Educ.* 28, 83–107. doi: 10.1177/1321103X070280010207

Passarotto, E., Altenmüller, E., and Müllensiefen, D. (in press). Music performance assessment: Noise in judgments and reliability of measurements. *Psychol. Aesthet. Creat. Arts.*

Preckel, F., Golle, J., Grabner, R., Jarvin, L., Kozbelt, A., Müllensiefen, D., et al. (2020). Talent development in achievement domains: a psychological framework for within- and cross-domain research. *Perspect. Psychol. Sci.* 15, 691–722. doi: 10.1177/1745691619895030

Ranelli, S., Smith, A., and Straker, L. (2015). The association of music experience, pattern of practice and performance anxiety with playing-related musculoskeletal problems (PRMP) in children learning instrumental music. *Int. J. Music. Educ.* 33, 390–412. doi: 10.1177/0255761415597151

Rodriguez-Linares, L., Vila, X., Lado, M. J., Mendez, A., Otero, A., Garcia, C. A., et al. (2022). RHRV: Heart rate variability analysis of ECG data (4.2.7). Available at: https://CRAN.R-project.org/package=RHRV

Rosseel, Y., Jorgensen, T. D., Rockwood, N., Oberski, D., Byrnes, J., Vanbrabant, L., et al. (2022). Lavaan: Latent variable analysis (0.6–12). Available at: https://CRAN.R-project.org/package=lavaan

Rossi, V., and Pourtois, G. (2012). Transient state-dependent fluctuations in anxiety measured using STAI, POMS, PANAS or VAS: a comparative review. *Anxiety Stress Coping* 25, 603–645. doi: 10.1080/10615806.2011.582948

RStudio Team (2021). RStudio: Integrated development for R. RStudio (2021.9.2.382). PBC. Available at: https://www.rstudio.com/

Spielberger, C. D. (1989). *State-Trait Anxiety Inventory: Bibliography* (*2nd ed*). Palo Alto, CA: Consulting Psychologists Press

Sporn, S., Hein, T., and Herrojo Ruiz, M. (2020). Alterations in the amplitude and burst rate of beta oscillations impair reward-dependent motor learning in anxiety. *elife* 9. doi: 10.7554/eLife.50654

Thompson, S., and Williamon, A. (2003). Evaluating evaluation: musical performance assessment as a research tool. *Music. Percept.* 21, 21–41. doi: 10.1525/mp.2003.21.1.21

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009a). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Yoshie, M., Shigemasu, K., Kudo, K., and Ohtsuki, T. (2009b). Effects of state anxiety on music performance: relationship between the revised competitive state anxiety Inventory-2 subscales and piano performance. *Music. Sci.* 13, 55–84. doi: 10.1177/1029864909013001003

Yoshimura, E., and Chesky, K. S. (2009). The application of an ergonomically modified keyboard to reduce piano-related pain. *Music Teach. Nat. Assoc. E-J.*, 2–13.

Yoshimura, E., Paul, P. M., Aerts, C., and Chesky, K. S. (2006). Risk factors for piano-related pain among college students. *Med. Probl. Perform. Art.* 21, 118–125. doi: 10.21091/mppa.2006.3024

Zaza, C. (1998). Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. *CMAJ* 158, 1019–1025.

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Effects of tailored interventions for anxiety management in choking-susceptible performing artists: a mixed-methods collective case study

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Introduction: Not being able to manage performance anxiety and subsequently experiencing a decline in performance have been called "choking under pressure". High trait anxiety and fear of negative evaluation, as well as low self-efficacy or self-confidence, can put performers especially at risk of experiencing choking. This study, therefore, examined the effects of psychological choking interventions tailored to "choking-susceptible" performing artists individually in a coaching setting.

Methods: We conducted a mixed-methods (QUANT + QUAL) collective case study with nine performing artists, who each received five individual coaching sessions. The tailored choking interventions comprised acclimatization training, goal setting, and pre-performance routines, including elements such as imagery, self-talk, and relaxation techniques. Before and after the 10-week intervention phase, they filled in questionnaires on trait performance anxiety, fear of negative evaluation, and self-efficacy, performed in front of a jury, and were interviewed about their experiences. Transcripts of interviews and coaching sessions were analyzed using thematic analysis. Heart rate measurements, weekly performance videos, and expert evaluations were also part of our comprehensive data.

Results: Quantitative data showed reductions in performance anxiety and fear of negative evaluation, and increases in self-efficacy and performance quality, from before to after the intervention phase. Most participants also had a lower heart rate when performing for the jury. Themes from qualitative analysis comprised managing nervousness and feeling more relaxed, becoming more self-confident, satisfaction with artistic and mental performance, feeling good and enjoying performing, and general positive effects.

Conclusion: Tailoring psychological interventions may provide several benefits for choking-susceptible performing artists.

KEYWORDS

performance anxiety, performing arts, performance under pressure, psychological interventions, tailored interventions, choking, mixed-methods

1. Introduction

Performing artists often have to perform in front of an audience, which may lead them to experience high pressure and anxiety, eventually harming their performance. Psychologists have called this "choking under pressure," a phenomenon that refers to performing worse than expected despite high skills and motivation to perform well (Baumeister, 1984). Choking has been mostly studied in sports (Mesagno and Beckmann, 2017; Gröpel and Mesagno, 2019), yet the drop in performance under pressure is also relevant in the performing arts (Hays, 2017). Consequently, and due to the similarities shared with sports (Mesagno et al., 2016), researchers have begun transferring sport psychological interventions into the field of performing arts and specifically testing them for performance under pressure (Tief and Gröpel, 2021; Lubert and Gröpel, 2022). However, compared to interventions designed to prevent choking in athletes (Gröpel and Mesagno, 2019), the observed benefits were fewer than those found in sports, as there was no effect on expert-rated performance quality. We thus need a deeper understanding of how sport psychological interventions may be specifically tailored to the performing arts in the pursuit of more pronounced performance-related benefits.

One issue when designing choking intervention studies is the presence of pressure. Participants must feel, and perform under, pressure to validate an intervention, which has been typically induced by setting up a competition, providing rewards, or performing in front of an audience (Gröpel and Mesagno, 2019). Alternatively, or additionally, researchers have studied "choking-susceptible" persons (i.e., individuals likely to experience choking), as they are expected to benefit most from choking interventions (Mesagno et al., 2008, 2009). Such persons are typically characterized by high trait anxiety, fear of negative evaluation (FNE), self-consciousness, or low self-efficacy (Wang et al., 2004; Mesagno et al., 2021).

Performance anxiety as a specific kind of trait anxiety can be defined as persisting worries about and heightened physiological arousal in relation to public performance, which may lead to a decline of performance skills in the presence of an audience (Salmon, 1990; Kenny, 2011). Studies with musicians and dancers highlight that the cognitive dimension of anxiety (e.g., worry) is often perceived as more debilitative to performance than the somatic dimension (e.g., "butterflies" in the stomach; Miller and Chesky, 2004; Walker and Nordin-Bates, 2010). Compared to individuals low in trait anxiety, those with high trait anxiety may be more prone to perceive evaluative situations as threatening (Byrne and Eysenck, 1995). Consequently, individuals high in trait anxiety experience higher levels of stress and state anxiety and also perform worse under pressure, than individuals low in trait anxiety (Kubzansky and Stewart, 1999; Schlotz et al., 2006). High trait anxiety is, therefore, considered to be one of the best predictors of choking (Wang et al., 2004).

It has been suggested that performance anxiety increases due to concerns about self-presentation (Mesagno et al., 2012). That is, performers strive to create positive images of themselves in the presence of an audience, but if they doubt their competence, they become anxious about their public image. A link between choking and concerns about self-presentation can be the performers' tendency to focus on the possibility that the audience will evaluate them as a social object, which elevates their FNE (Mesagno et al., 2012). Indeed, it has been demonstrated that high FNE leads to choking, whereas low FNE does not (Mesagno et al., 2012).

Finally, a performer's confidence in their ability to self-regulate themselves and their environment has been identified as a protective characteristic against the debilitative effects of anxiety. With strong self-confidence, anxiety can indeed be perceived as facilitative for performance (Hanton et al., 2004). This has also been shown with professional dancers: self-confidence may protect against debilitative performance anxiety, as it helps to feel in control and reinterpret anxiety symptoms (Walker and Nordin-Bates, 2010). Whereas self-confidence is a generic term that indicates "strength of belief but does not necessarily specify what the certainty is about", self-efficacy means the "belief in one's agentive capabilities, that one can produce given levels of attainment" regarding a specific skill or task (Bandura, 1997, p. 382). Self-confidence is a more commonly used term in everyday language, yet may often mean self-efficacy in the sense of one's confidence in a particular ability. Throughout the article, we apply the respective terms as used in the questionnaires or in participants' quotes. In music, self-efficacy for performing was shown to be a strong predictor of performance quality in both self-evaluations and jury evaluations (Ritchie and Williamon, 2012).

In sum, individuals high in trait performance anxiety and FNE and low in self-efficacy may be especially susceptible to choking. Indeed, musicians high in trait performance anxiety benefited from choking interventions, whereas those low in trait anxiety did not, presumably because the experience of pressure was only at a medium level (Lubert and Gröpel, 2022). Consequently, to shed more light on the effectiveness of choking interventions in the performing arts, we need to sample choking-susceptible artists and let them perform under pressurized conditions.

Another issue in intervention research is "person-treatment matching," which refers to matching intervention strategies with the characteristics and needs of an individual. Several researchers have emphasized the importance of tailoring interventions to performers' specific needs (Lidor and Mayan, 2005; Cotterill et al., 2010), as tailored interventions are likely to induce more visible benefits than generic "one-size-fits-all" interventions and might also increase the individuals' willingness to apply the intervention (Mesagno et al., 2021). This could be especially relevant with performing artists: some dancers who felt unable to manage their anxiety believed that psychological interventions would not help them, as everybody has different needs and coping styles (Walker and Nordin-Bates, 2010). The implementation of interventions inspired by sport psychology may therefore be challenging for artists and requires a domain-sensitive, holistic approach (Pecen et al., 2016). Pioneering work has been done in two case studies with musicians who received tailored psychological skills training, which showed facilitative effects on different psychological and performance aspects (Hatfield, 2016; Hatfield and Lemyre, 2016). Hence, a tailored approach could provide valuable insights into informed research and practical applications in music, dance, and acting.

Choking theories imply that performers fail under pressure because of increased anxiety and subsequent maladaptive attention (Mesagno and Beckmann, 2017). Psychologists have,

therefore, developed interventions aimed to adapt performers to pressure and improve their concentration (Gröpel and Mesagno, 2019). These interventions comprise, but are not limited to, acclimatization training, pre-performance routines, and goal setting. Acclimatization training refers to practicing under mild anxiety conditions, which can either be a kind of behavioral exposure (e.g., the presence of an audience) or a simulation of expected demands and consequences of an individual's performance (e.g., rewards, punishments, and perceived evaluation by coaches). Evidence shows moderate-to-large effects of acclimatization training on posttest performance under pressure, indicating its effectiveness in familiarizing performers with pressure (Low et al., 2021). A pre-performance routine (PPR) is a set of cognitive and behavioral elements a performer systematically engages in prior to performance execution (Moran, 1996). The main function of a PPR is to enhance concentration by directing attention to task-specific cues and minimizing internal or external distractions (Cotterill, 2010). It typically comprises task-specific motor actions, such as when a dancer marks parts of the choreography with their hands. Notably, such behavioral elements are often combined with one or more mental strategies, e.g., with imagery (e.g., visualization of successful performance), self-talk (e.g., positive self-instructions), or relaxation elements (e.g., a couple of deep breaths before performing). Meta-analyses show moderate-to-large effects of PPRs in sports and support the benefits of both behavioral and mental elements for performance under pressure (Rupprecht et al., 2021). Finally, setting process goals has often been used in sports to facilitate task-relevant attention when performing a specific skill (Weinberg and Butt, 2014). A process goal is focused on the key steps underpinning the performance (e.g., a cellist maintaining a smooth bow stroke) and is fully controllable by the individual, as opposed to an outcome goal which is focused on the desired end result (e.g., winning a role or a prize) and thus often not within the performer's full control. Researchers have documented significant benefits of goal setting for sports, with process goals having the largest effects on performance and self-efficacy (Williamson et al., 2022). These interventions are not limited to sports, but have the potential to help performing artists as well.

Previous intervention research in the performing arts has had a stronger focus on reducing anxiety than on improving performance, and is unevenly distributed between domains: while there are numerous studies with musicians, there are very few with dancers and actors. In the past decade, several researchers in music performance have investigated some of the interventions described above within extensive psychological skills training (PST) similar to or based on PST interventions in sports psychology. These training programs consisted of different combinations of cognitive restructuring, behavioral exposure to performances, identification of strengths, goal-setting, imagery, practice strategies, arousal regulation, and relaxation, but were not specifically focused on high-pressure performance settings. Studies showed that PST interventions had a positive effect on music performance anxiety and performance quality in young musicians (Braden et al., 2015), aspiring professionals (Spahn et al., 2016), and musicians of all levels (Hoffman and Hanrahan, 2012). PST interventions for musicians that also included PPRs were associated with higher self-efficacy and more control over or reduction of anxiety after the training, but measures of performance quality were often either lacking (Osborne et al., 2014; Hatfield, 2016; Kinne, 2016) or provided inconclusive results (Kageyama, 2007; Clark and Williamon, 2011). In contrast, a recent study showed improvements in both performance quality and anxiety after a PST intervention including PPRs, goal-setting, positive self-talk, imagery, memorization, arousal regulation, and relaxation (Cohen and Bodner, 2019). In dance, PST was explored in a pilot study aiming at injury prevention, rather than anxiety management for performance under pressure (Skvarla and Clement, 2019).

Remarkably, none of the previous experimental studies on PST were focused on individuals with high trait performance anxiety. Instead, exploratory studies targeted at highly anxious performing artists have so far only investigated acceptance and commitment therapy or coaching (ACT or ACC). In music, a case study was undertaken with a highly anxious violinist, who was guided toward mindfulness and acceptance of her unwanted anxiety symptoms through ACT (Juncos and Markman, 2016). Her performance quality improved after the intervention, and even though symptom reduction had not been the study aim, performance anxiety was reduced as well. However, whether the pre- and post-intervention performances "to a small audience" (Juncos and Markman, 2016, p. 8) were truly perceived as pressure-inducing remains unclear. A study with six highly anxious performing arts students receiving group ACC indicated reduced performance anxiety after the intervention, but there was no effect on performance, and the performance setting was again likely no high-pressure situation (Mahony et al., 2022).

Taken together, evidence for the effectiveness of interventions similar to those tested to prevent choking in sports is generally promising. However, studies have not yet been focused on improving performance quality in high-pressure performance settings or on performing artists with high performance anxiety. Exploratory interventions targeted at highly anxious individuals show mixed evidence and were likely not conducted in high-pressure situations. With this study, we, therefore, intend to advance the knowledge transfer between sports psychology and the performing arts of music, dance, and acting by sampling choking-susceptible performing artists and tailoring acclimatization training, goal-setting, and/or PPRs, including elements such as imagery, self-talk, or relaxation techniques, to their needs in relation to performance under pressure. Our aim is to investigate the effects of these interventions on participants' performance quality and the key personal characteristics that make them susceptible to choking (anxiety, FNE, and low self-efficacy or self-confidence), and to examine their experiences with the interventions using a collective, mixed-methods case study design.

2. Materials and methods

2.1. Design and approach

This collective case study is embedded in a theoretical approach of critical realism: by believing in a reality independent of our construal of it, and in the notion that all our construed knowledge about this reality is incomplete and interpretative, we adopt a combination of ontological realism with epistemological relativism (Easton, 2010; Braun and Clarke, 2021). A collective case study extends an instrumental case study to several cases,

which is justified by an interest in a phenomenon rather than the intrinsic interest in just one particular case (Stake, 1998). In choosing a collective case study, we aimed for an in-depth, multi-perspectival investigation of implementing and evaluating tailored interventions with a small number of highly anxious performing artists from different genres to foster a better understanding, or potentially better theorizing, for an even larger case collection in future research (Stake, 1998; Simons, 2009; Hodge and Sharp, 2019). Inspired by a similar approach with choking-susceptible athletes (Mesagno et al., 2008), we conceptualized this pre–post evaluation of intervention effects as a parallel mixed-methods design with simultaneous collections of qualitative and quantitative data (Kuckartz, 2014). We consider both qualitative and quantitative approaches as equally important to address our research questions (QUANT + QUAL) and thus interleaved them dynamically and interactively in every phase of the study (Kuckartz, 2014). Consequently, it appears appropriate to apply quality judgment criteria for the quantitative and qualitative aspects of the study separately, while also seeing them as discrete and bounded (Sparkes, 2015).

2.2. Participants

Participants were recruited from a renowned performing arts university in Austria. We selected them based on both qualitative and quantitative considerations. Musicians, dancers, and actors were invited via email to sign up via a link to an online questionnaire if they felt they were generally strongly affected by performance anxiety. Twenty-one performing arts students considered this to apply to them by accepting the invitation online. They gave informed consent according to the Declaration of Helsinki and filled in demographic as well as three psychological questionnaires for the subsequent quantitative identification of choking-susceptible participants. Ten participants were then purposively selected (see below). Due to COVID-19 and uncertainties about performance schedules at the time of selection, some of those originally chosen withdrew their participation. One musician did not wish to apply psychological interventions and thus received a different kind of coaching. Consequently, she was excluded from the analyses in this article. The final sample (eight females and one male) included six musicians, two dancers, and one actress. They were 20–26 years old (M = 23.3, SD = 2.2), had on average 15.2 years (SD = 2.9) of experience in their respective performance domain, and practiced or trained their skills for an average of 26.1 h (SD = 13.8) per week. Table 1 shows their demographic data. All names are pseudonyms. The study was approved by the Institutional Review Board of the first author's institution (#2021/S/004) and ran from April to July 2021. Participants received 100 EUR for their participation.

2.3. Materials and procedure

The study consisted of four distinct phases: (1) selection, (2) pretest, (3) intervention, and (4) posttest (Figure 1). Materials, interviews, and coaching sessions were in German and English, depending on the participants' language preferences.

During *selection*, all invited artists completed questionnaires on trait anxiety, FNE, and self-efficacy. Trait performance anxiety was measured with a short version of the Kenny Music Performance Anxiety Inventory (K-MPAI; Kenny, 2011). We included 19 items from three dimensions: proximal somatic anxiety, worry/dread, and focus on self/other scrutiny. An example item is: "Prior to, or during a performance, I get feelings akin to panic". A 7-point scale ranging from 0 (*strongly disagree*) to 6 (*strongly agree*) was employed. The K-MPAI is widely used, and its reliability and validity have been supported by evidence from numerous studies (e.g., Chang-Arana et al., 2018). Fear of negative evaluation was assessed with the Brief Fear of Negative Evaluation Scale-Revised (Carleton et al., 2006) and its German translation (Reichenberger et al., 2016). The scale consists of 12 items, such as "I am afraid that others will not approve of me", and items were answered on a 5-point scale from 1 (*not at all characteristic of me*) to 5 (*extremely characteristic of me*). Psychometric testing of the BFNE-II has shown acceptable psychometric properties (Carleton et al., 2006; Reichenberger et al., 2016). Finally, self-efficacy was measured using the English and German versions of the General Self-Efficacy Scale (GSE; Schwarzer and Jerusalem, 1995, 2003). Their 10 items have a 4-point scale ranging from 1 (*not at all true*) to 4 (*exactly true*), an example being "I can usually handle whatever comes my way". Reliability and validity for this scale have been extensively established (Schwarzer and Jerusalem, 1995, 2003). Artists with the highest percentile rank above the norm in trait performance anxiety and FNE, and the lowest percentile ranks below the norm in self-efficacy, were selected to participate.

In the *pretest*, participants were exposed to a psychosocial stressor using a procedure similar to the Trier Social Stress Test[1] (TSST; Kirschbaum et al., 1993): participants were asked to perform a mental arithmetic task in front of a jury, followed by performing audition excerpts of their choice. Before and during the stress exposure, we measured participants' state anxiety through self-reports and also physiologically with heart rate (HR) using a chest belt and a smartwatch (Suunto Ambit3 Run, Suunto, Finland). Upon arrival at the lab, participants were given 10 min to warm up and were then equipped with the chest belt. Thereafter, they moved to another room (i.e., the performance venue), where they first sat quietly for a 90-s baseline and then performed the mental arithmetic task in front of a jury and a video camera. The jury consisted of two persons who were not introduced to the participants and who were instructed to behave neutrally. The task was to sequentially subtract the number 13 (pretest) or 17

1 The Trier Social Stress Test (TSST) is the most widely used and well-validated laboratory stress protocol (Henze et al., 2017; Seddon et al., 2020). It consists of two tasks, a free speech and a mental arithmetic task, which are performed in front of a jury. Because our study required testing participants under pressure, we decided to employ the TSST to reliably induce stress, yet adjusted it to our setting. In particular, we used the original mental arithmetic task as the first task, followed by performing audition excerpts instead of the free speech in the original procedure.

TABLE 1 Demographic data of each participant.

Pseudonym	Performance major	Genre	Age	Gender	Nationality	Years in the domain	Hours/week	Study level and semester
Anne	Dance	Contemporary	24	Female	Austrian	18	38	B7
Bianca	Trumpet	Classical	20	Female	Austrian	10	14	B1
Coco	Dance	Contemporary	22	Female	Canadian	18	24	B6
Julia	Accordion	Classical	20	Female	German	12	28	B4
Lucy	Acting	Stage acting/ musical	26	Female	German	15	56	B8
Mia	Violin	Baroque	23	Female	Hungarian	19	15	B7
Tom	Trumpet	Jazz	25	Male	German	15	28	B4
Vivi	Clarinet	Classical	25	Female	Austrian	15	17	M2
Zoe	Voice	Jazz	25	Female	Turkish	15	15	B2

B, bachelor's program; M, master's program.

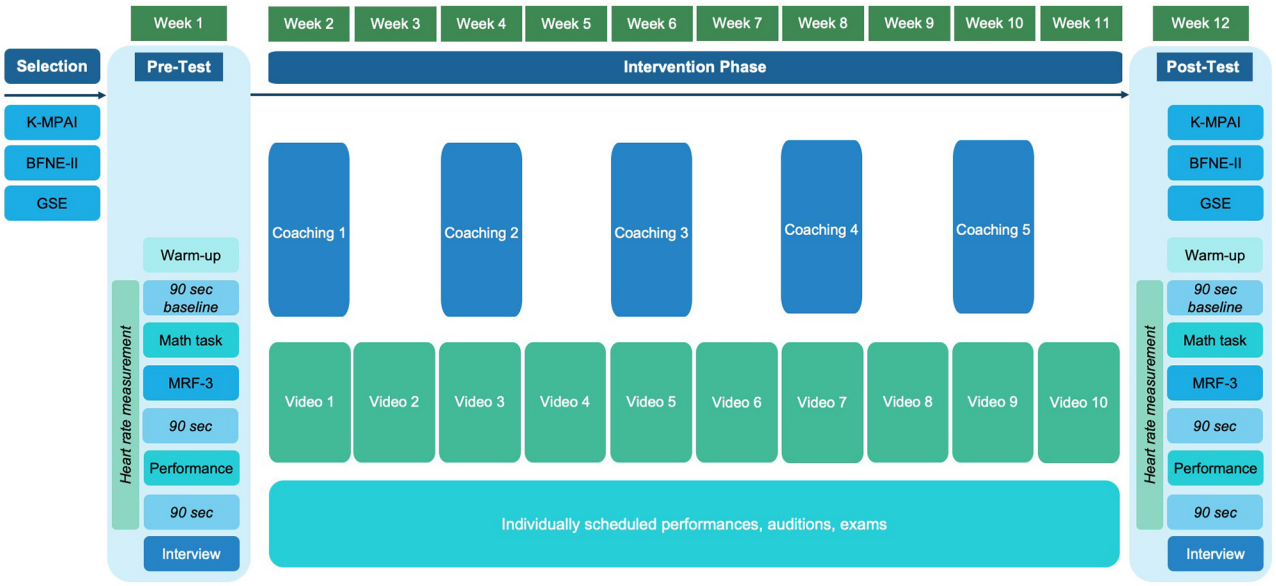

FIGURE 1
Design and procedure. K-MPAI, Kenny Music Performance Anxiety Inventory; BFNE-II, Brief Fear of Negative Evaluation Scale-Revised; GSE, General Self-Efficacy Scale; MRF-3, Mental Readiness Form.

(posttest) from 1,022 and verbally report the answers aloud for 3 min. If they made a mistake, they were made aware of it and asked to start over from 1,022. Immediately after the arithmetic task, participants filled in the Mental Readiness Form-3 (MRF-3; Krane, 1994) to self-report their state anxiety. In particular, they set marks for their present feeling on three separate 100-mm lines, which were anchored between *calm* and *worried* for cognitive anxiety, *relaxed* and *tense* for somatic anxiety, and *confident* and *not confident* for self-confidence. The measured length between the left end of the line and the participant's mark was calculated as a score out of 100, with higher scores indicating higher anxiety. Participants then stood still for another 90 s before performing audition excerpts of their choice, which lasted on average 4.0 min (SD = 1.2). Detailed information on their audition tasks can be found in Supplementary Table S1. To measure how quickly their HR would return to baseline, they then remained still for another 90 s. To minimize the effect of merely improving newly learned excerpts over the following weeks, they had been asked to have prepared them in the way they would for an audition. Finally, after completing the audition excerpts, participants were interviewed about their performance experience. We developed an interview guide similar to Mesagno et al. (2008): a semi-structured approach with pilot-tested, open-ended questions (i.e., prefaced by how? what? in what way?). The interviews explored participants' performance experiences, their focus, emotions, and mental strategies, and their evaluation of

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TABLE 2 Tailored interventions for each participant.

	Goals	Intervention					
		PPR	Imagery	Acclimatization	Relaxation	Goal-setting	Self-talk
Anne	Improve self-confidence, stage presence, and control	✓	✓	✓			
Bianca	Improve self-confidence	✓	(✓)	✓	✓	✓	✓
Coco	Improve mental performance preparation, learn strategies and techniques	✓	✓	✓	✓		
Julia	Show ability on stage, play from memory without blackout, enjoy performing	(✓)	✓		✓		✓
Lucy	Improve self-confidence, immerse in the moment, let go	✓	✓				✓
Mia	Understand own behavior during performance, improve stage presence	✓	✓	✓	(✓)		✓
Tom	Learn strategies for self-help	✓	✓	✓	✓		
Vivi	Improve self-confidence, show ability on stage	✓			✓	✓	✓
Zoe	Improve self-confidence	(✓)	(✓)			✓	

(✓), intervention was implemented together; (✓), technique was being discussed, but either already learned before the study or not implemented during the intervention phase.

TABLE 3 Results of paired-sample *t*-tests with effect sizes (Cohen's d_z).

Variable	*M* (*SE*)		*t*-Test		
	Pre-test	Post-test	*t*(8)	*p*	d_z
Traits					
Trait performance anxiety	4.00 (0.39)	2.92 (0.27)	−2.88	**0.010**	0.96
Fear of neg. evaluation	4.15 (0.13)	3.38 (0.26)	−3.81	**0.003**	1.28
Self-efficacy	2.81 (0.18)	3.23 (0.14)	3.10	**0.008**	1.02
States					
Cognitive anxiety	55.44 (4.67)	24.44 (5.15)	−5.72	**0.001**	1.91
Somatic anxiety	65.11 (6.05)	33.22 (8.06)	−3.26	**0.006**	1.09
Confidence	50.67 (8.02)	67.33 (7.37)	4.15	**0.002**	1.38
Heart rate (AUC_g)	7,761.05 (570.17)	7,385.59 (505.92)	−1.38	0.102	0.46
Performance					
Performance quality	6.64 (0.54)	8.11 (0.43)	2.80	**0.013**	0.93

AUC_g, area under the curve with respect to the ground. Significant *p*-values are marked in bold.

how they performed. The pretest interviews took 22–44 min (M = 29.4, SD = 6.6).

The *posttest* was identical to the pretest, but preceded by the questionnaires from the selection phase a second time. It was required that participants perform the same audition excerpts as in the pretest. The semi-structured posttest interview included questions referring to each participant's interventions in addition to the questions also asked in the pretest. They closed with questions about other potential influences during the intervention time, what participants had learned during the study, and what they took away from the coaching. Posttest interviews lasted 29–63 min (M = 44.8, SD = 11.3). After the interview, participants were paid and thanked.

Upon the completion of data collection, interviews and coaching sessions were transcribed verbatim using the transcription software f4transkript (audiotranskription, Germany). The overall performance quality of all anonymized video recordings was evaluated individually on a scale from 1 (*bad*) to 10 (*excellent*) by nine experts, who were renowned professionals, professors, and/or judges for auditions and competitions in the respective domains. They were instructed to do so in the same

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TABLE 4 Overview of themes and subthemes with examples.

Theme	Subtheme	Example
Managing nervousness and feeling relaxed	Experiencing nervousness	"I was so scared that I would like not gonna make it" (Zoe)
	Struggles due to performance circumstances	"The hall is extremely annoying to play in" (Vivi)
	Feeling more relaxed and calm	"Actually I felt really calm" (Mia)
Becoming more self-confident and more proud	Confidence in one's ability to perform and to deal with unexpected situations	"Generally I simply have a bit more confidence now that I do indeed play well in any case" (Bianca)
	Being more courageous	"It was fun to try it out. Rather than like, 'oh gosh, I was anxious about it'" (Coco)
	Less concern about negative evaluation	"I care less about what people think about me" (Tom)
	Stronger sense of artistic identity and pride	"I was really proud and I felt like (...) 'yes, I was born to do this!'" (Zoe)
Satisfaction with artistic and mental performance	Performance highlights	"A highlight was now actually the intermediate exam" (Julia)
	Performance went well	"It went well, like it's just, I didn't expect to" (Coco)
	Own expectations were met	"I implemented exactly what I had aimed for" (Lucy)
	Recognition of sub-par aspects	"The intonation was unfortunately not good, also because of the weather and because of me" (Vivi)
	Other's feedback and perceptions	"Every teacher told me beautiful things. I got really good feedback" (Zoe)
Feeling good and enjoying performing	Feeling comfortable	"I have felt rather secure most of the time" (Tom)
	Having fun	"It was really fun then in the moment" (Lucy)
	Flow experience	"Now I think I was more in the flow" (Mia)
General positive effects of the intervention		"I think these techniques are always helpful, not just for the performance, but also generally when one is stressed or somehow, yeah, confronted with a difficult situation or when one does not know how to deal with something" (Anne)

way they would for a professional audition procedure. Given the variety of domains, instruments, and genres, as well as the extensive amount of video material per participant, they only rated the respective participant for whose field they were indeed experts, so there was one expert rating per participant.

2.4. Intervention

During the 10-week *intervention* phase, participants received five bi-weekly individual coaching sessions, with an average duration of 54.0 min ($SD = 4.9$), from the first author who is a psychologist and certified psychological coach. To ensure the personal relevance of the interventions, participants were encouraged to express their own goals for the whole intervention period as well as each coaching session. Interventions were then tailored to each participant's specific problems of performing under pressure by accommodating their own goals and requests during each session. Six participants wanted to increase their self-confidence, four asked for strategies for mental performance preparation and self-help, and two also wanted to enjoy performing and get immersed in the moment.

Every session was somewhat unique, but in the following, we describe certain recurring elements. Some typical questions referred to the participant's hopes for ideal outcomes of the entire 10-week period (first session) as well as for each session at the beginning, how the participant had been doing the 2 weeks before (sessions 2–4 in particular), how the coach could support their concern(s), and which specific steps they would take in the following weeks (sessions 1–4). Session 5 was introduced as an opportunity to reflect on the past sessions, on aspects that had been helpful, and on how participants envisioned to continue in future (e.g., among the closing questions was "what would you like to tell your future self?"). When participants had expressed a certain goal or need, they received psychoeducation about potentially matching psychological strategies. The chosen strategy was then tried out together, sometimes written down by the participant, or modified/adapted according to their experiences either during the session or in the field.

The tailored choking interventions included PPRs, goal-setting, and acclimatization training (see Table 2). To help participants with the implementation of these interventions, they were provided with instructions in imagery, self-talk (including reappraisal cues), and techniques for relaxation and concentration, such as centering (Greene, 2002), left-hand contractions (Beckmann et al., 2013), and deep breathing. In order to match participants' individual goals and needs, some were additionally instructed in Progressive Muscle Relaxation

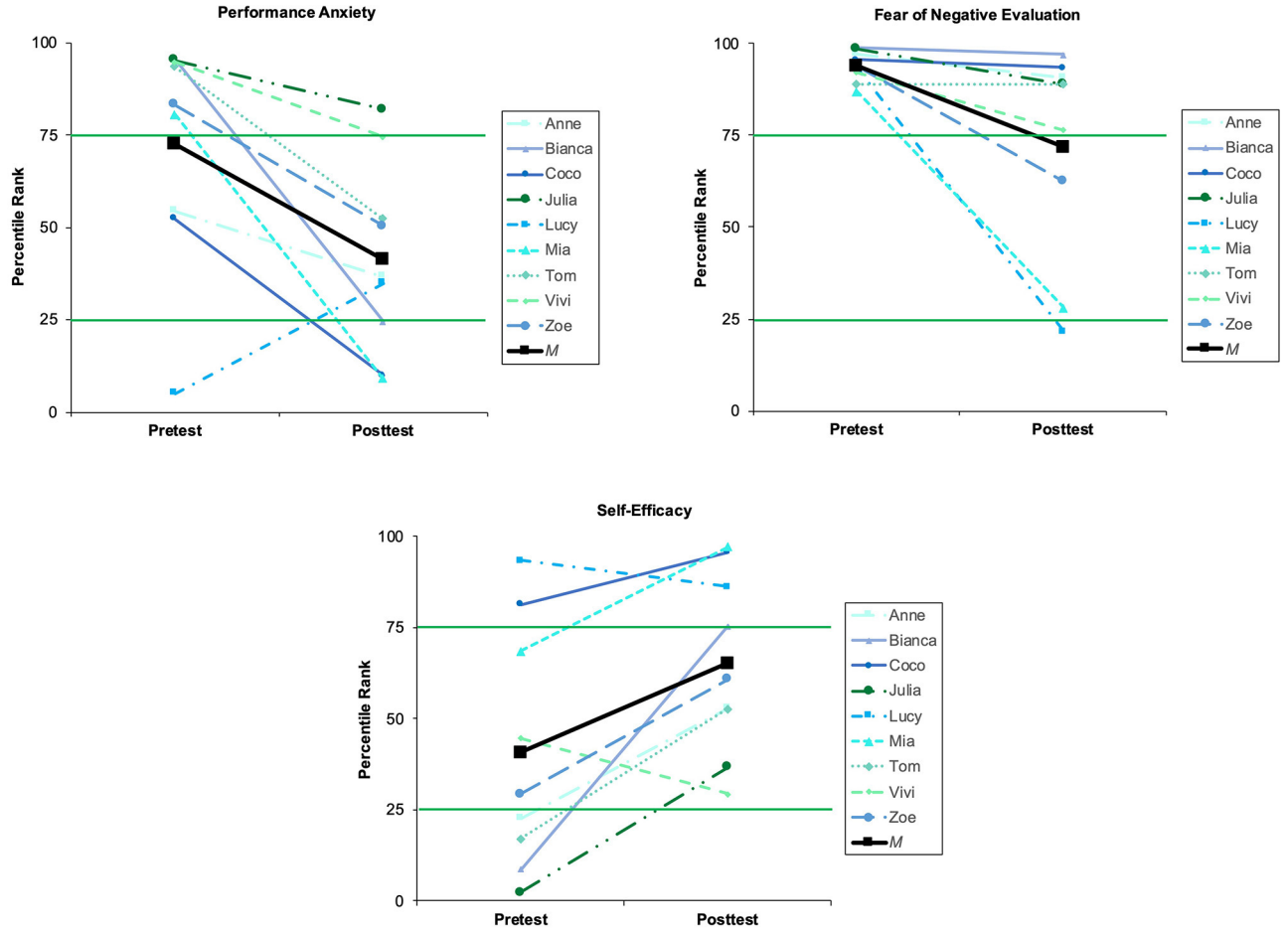

FIGURE 2
Percentile ranks for trait performance anxiety, fear of negative evaluation, and self-efficacy in pre- and post-tests.

and Autogenic Training. Participants were requested to test the practical application of their respective interventions in simulated or actual performances. Simulated performance scenarios were created by the participants themselves, whereas actual ones included professional auditions and graded performances at university. Participants were asked to submit weekly video recordings of these performances.

2.5. Quantitative analysis

Questionnaire data, quantitative expert evaluations, and HR measurements were analyzed using SPSS 27.0 (IBM Corp.; Armonk, NY, United States). Questionnaire scores were computed by averaging the responses across respective items. In addition, we determined percentile ranks for each participant in relation to the norm. To analyze HR during pretest and posttest, we applied the formula from Pruessner et al. (2003) to calculate the "area under the individual response curve with respect to the ground" (AUC_G) for each participant. To complement our qualitative and descriptive data, we used paired-sample *t*-tests, with a level of significance at $p < 0.05$ (one-tailed).

2.6. Qualitative analysis

We analyzed the transcripts of interviews and coaching sessions using reflexive thematic analysis (Braun and Clarke, 2021) with Quirkos (Quirkos Limited, United Kingdom). The first author, who also collected the data, kept a reflexive journal throughout data collection and analyses and engaged in extensive reading and re-reading of transcripts to enhance familiarity with the data. She began the coding process focused on the research aims, while also noting passages potentially relevant to illuminating the underlying mechanisms of the interventions. Arising issues and questions were frequently discussed with the second author. Having re-read and refined initial codes, we developed preliminary themes together, including descriptions, subthemes, and exemplary quotes. The third author served as a critical friend to challenge and discuss these initial themes and encourage alternative understandings (Smith and McGannon, 2018).

3. Results

As we consider our quantitative and qualitative results to be of equal importance, we present them in an interleaved fashion,

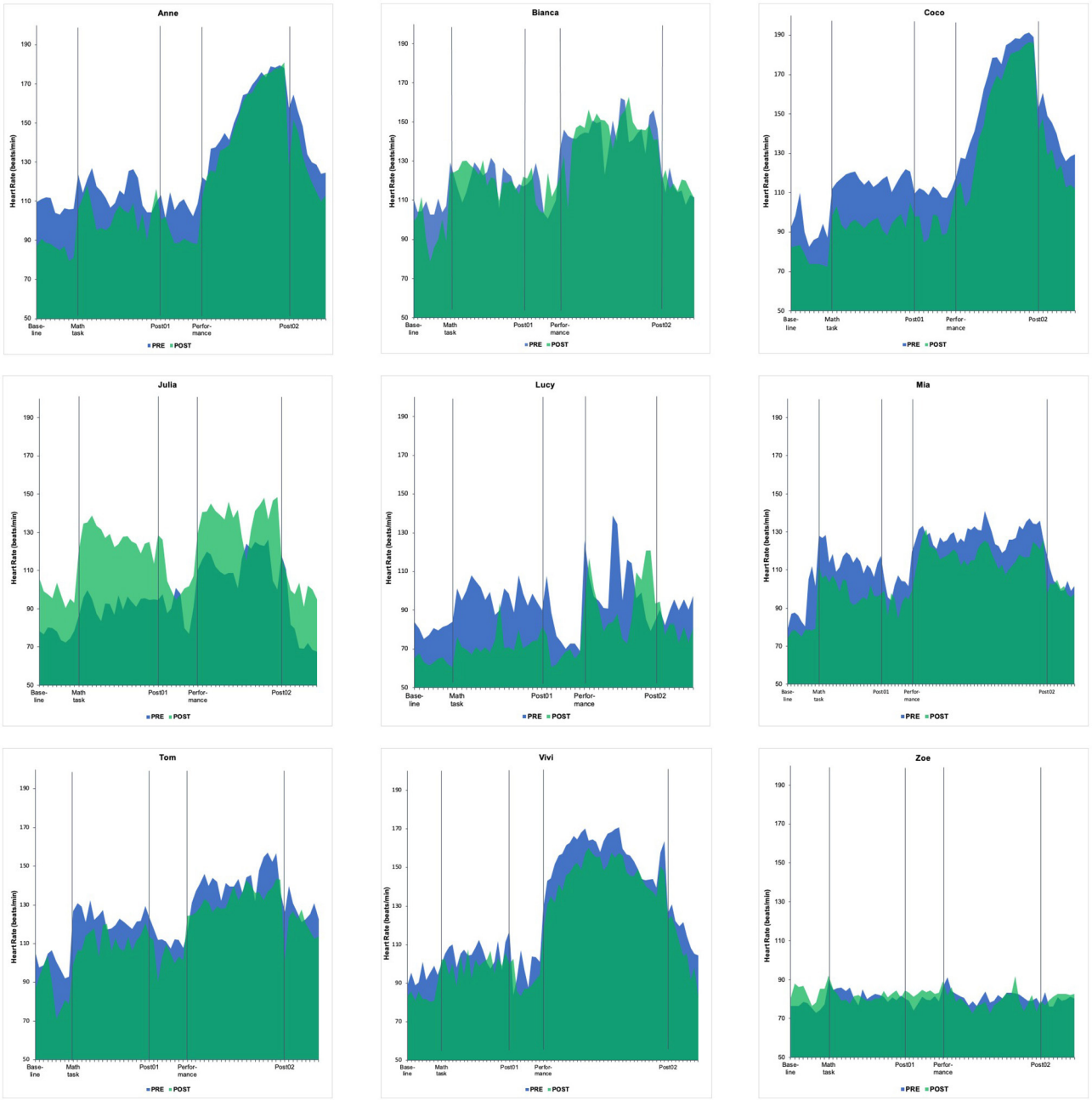

FIGURE 3
Heart rate in pre- and post-tests.

structured according to the different outcomes we investigated. Quantitative results are displayed in Table 3, and the themes from the qualitative analysis are displayed in Table 4. Quotes from participants to describe the themes are provided without corrections in English or as translations from German.

3.1. Experiencing and managing performance anxiety

Both trait performance anxiety and FNE appeared to significantly decline from pre- to post-intervention (Figure 2). One participant, Lucy, showed an increase in trait performance anxiety, which might be explained by a rather low percentile rank in the K-MPAI she had in the pretest, presumably because she underestimated how anxious she actually is. As she expressed regarding an important performance: "...and so suddenly 'bam', the whole nervousness, which I haven't known like this in a while, was there." Participants never used the term anxiety, but referred to nervousness or stress instead, therefore we consider them as synonyms. Despite the overall decline in anxiety, *experiencing nervousness* before performances was still an important theme for some participants: "I thought that I had left this behind, but there it was again" (Tom); "I was so stressed before the stage" (Zoe).

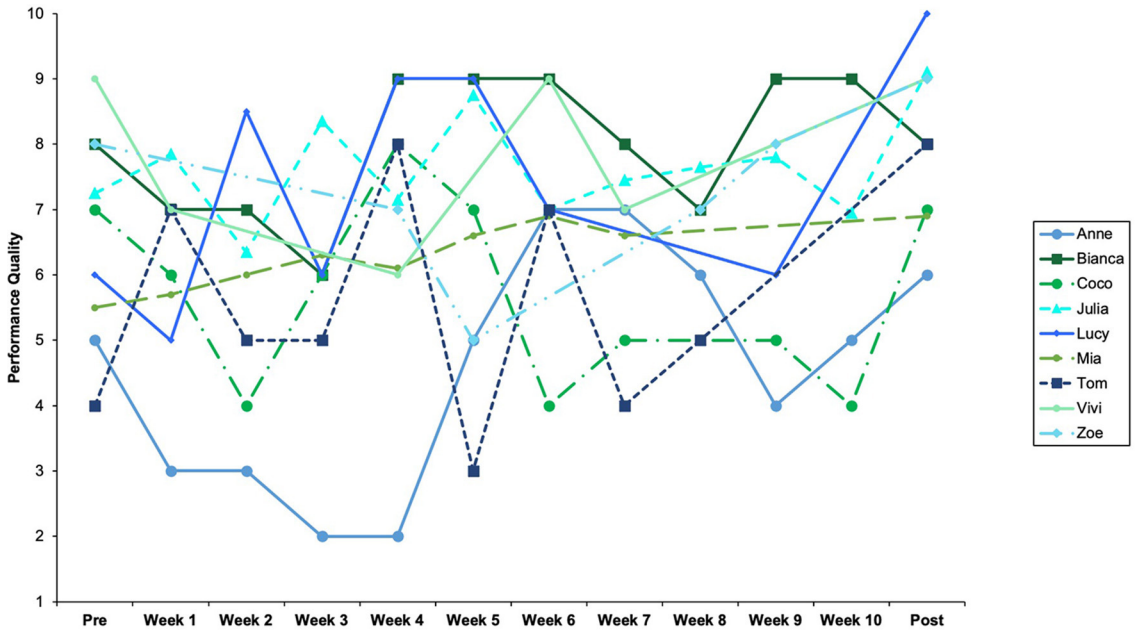

FIGURE 4
Expert performance evaluations.

They described becoming anxious often because they felt like they had to prove their artistic ability and show everything they had prepared: "About 2 seconds before I went on stage, there was the thought 'You're only allowed to show this once, you may never do it again, you now have to show everything you thought, and ideas, and just have fun now, because you can never repeat this, it's now the only and last time'. And your friends are watching and the jury is watching" (Lucy).

The intensity of the anxiety experience was amplified by the fact that participants had not been on stage for months because of the COVID-19 pandemic. Their nervousness was, therefore, also elicited by *struggles due to performance circumstances*, such as unexpected situations or adverse conditions. In particular, there was a feeling of not being able to communicate with the audience when face masks had to be worn during the performance. Other struggles that inhibited communication were caused by bad acoustics or having to play behind a wall in an audition. Participants further talked about being overwhelmed by the sudden increase in performances after lockdown and a subsequent lack of preparation and time pressure: "the problem was that I had had too little preparation. (…) It was just everything within a very short time. It was simply too much" (Vivi).

Notably, both quantitative and qualitative data indicated that participants learned to better manage their anxiety. They generally reported lower state anxiety before the posttest performance, with significantly lower values in both cognitive anxiety and somatic anxiety in the MRF-3 compared to the pre-test (Table 3). HR similarly decreased from pre- to post-test (Figure 3), but not significantly so. Furthermore, an important theme was gradually *feeling more relaxed and calm* during performance after learning, and experimenting with, different strategies during the intervention period: "and then I actually could calm me down. And that was a really cool feeling" (Mia). Other participants similarly described managing their nervousness effectively. Lucy in particular was able to learn from her dissatisfaction with one performance, improving her anxiety management and performance during a subsequent audition:

> I have now noticed what it is when I am too much. I have noticed what it is when I am too little (. …) 'how do I achieve this balance?' And I somehow then managed that in the audition there and I was totally good, it was really fun.

The effect of applying the interventions was also perceived as an absence of physical symptoms, such as shaking, palpitations, or being cold: "I didn't have so many palpitations, so I mean with me it is often like that, mainly due to excitement or stress, that I really, yeah, that it immediately manifests itself physically, but this time it did not" (Anne).

Most participants exhibited a lower HR in the posttest, yet the HR measurement itself also led to discomfort: "what really bothered me is that the thing here [the chest belt] actually made me/ like I could feel my heartbeat all the time" (Mia); "this is kind of also stressful to see someone measuring your heart rate" (Zoe). Julia's HR even increased by 26% in the posttest. However, she evaluated this positively: "I arrived quite tired because it was a hard week (…) And I was actually rather glad that a bit of nervousness came, as one becomes more awake then". This illustrates that heightened physiological arousal before a performance does not necessarily need to be debilitative. In the same vein, Julia said about her successful recital a few weeks before the posttest: "I was monstrously nervous, of course. But then it wasn't a problem." Vivi even remarked that she needed a certain amount of nervousness for optimal performance: "the reason for some mistakes is that I was

not alert enough (. . . .) The concentration is not quite there (. . . .) When I'm nervous, I am always a tad more precise". Taken together, participants' performance anxiety decreased in the posttest, but they also acknowledged that they felt nervous in certain situations. This was sometimes facilitative, but often had to be regulated via an anxiety management strategy.

3.2. Strengthened self-confidence and artistic identity

Overall, participants appeared to show both significantly increased general self-efficacy after the intervention (Figure 2) and significantly higher confidence before the posttest performance (Table 3). Lucy and Vivi, however, reported slightly decreased self-efficacy in the GSE in the posttest. Interestingly, this did not correspond with their interviews. Lucy dropped from an already high percentile rank of 93 in the pretest to 86 in the posttest, yet in her interview, she said about the coaching: "it has really greatly strengthened my self-confidence." Similarly, Vivi stated in contrast to her questionnaire: "I am now in a phase in which I am getting much more self-confident."

Our thematic analysis revealed that *confidence in one's ability* was expressed as trust that one *can* indeed play and perform, and having this trust allowed participants to let go more and not control too much: "I can play, because in that moment I could rely on it going well (. . . .) there I could listen relatively well. Yeah and that was very beautiful" (Julia). This confidence was extended to having strategies for managing anxiety and uncertainty: "and so generally I simply have a bit more confidence now that I do indeed play well in any case, but can also learn how to deal with my, yeah, nervousness" (Bianca); "that I can optimize my preparation (. . .), but also be ready to adjust" (Coco). Knowing such strategies gave participants a sense of security: "and there I was so certain and secure that nothing could faze me in that moment, nothing disturbed me" (Lucy); "I believe it just gives me like a general feeling of a bit of a greater security" (Tom).

Having trust and security, participants also described themselves as *being more courageous*, e.g., when improvising, taking risks on stage, or trying new things: "I was totally free (....) I knew nothing can happen now" (Lucy). Some also considered it courageous to show themselves on social media: "I already posted the videos from [prestigious performance venue] (...) I have never ever posted a video or a photo of myself on the stage before that. Never. (. . .) That's a big step" (Zoe). With their strengthened self-confidence, they noticed *less concern about negative evaluation*: "I'm actually not afraid of other musicians anymore" (Mia); "I didn't think much of like 'how do I look?' and what people think" (Zoe). This is also underlined by the questionnaire results on reduced FNE described above.

Finally, enhanced self-confidence became visible in expressions of a *stronger sense of artistic identity and pride*. Being proud comprised all aspects of being an artist: "that I can indeed be proud of myself and that actually everything is alright the way it is, how I play and all" (Bianca); "I was really proud and I felt like 'yes I was born to do this, like this is me, this is what I should do'" (Zoe). Especially after experiencing several lockdowns, being or becoming aware of one's artistic identity was quite powerful and meant to be fully connected to what one is doing: "it's like safe, it's kind of indestructible now, it's me and the violin" (Mia). Zoe elaborated that she was "embracing like who I am. And I was kind of lost, maybe because of lockdown (. . .) I'm a musician. (...) I'm like very proud of what I'm doing, what I'm going to do and I can see the future."

3.3. Positive feelings during performance and satisfaction with performance quality

Performance quality appeared significantly higher in the posttest compared to pretest performances (Table 3). The expert ratings for pre- and post-tests and weekly performance videos are displayed in Figure 4. It should be noted that when comparing pre- and post-tests on an individual level, performance quality either increased or remained stable. For the intervention period, however, performance quality fluctuated strongly for all participants except Mia, whose performance varied slightly, but otherwise slightly increased. For some participants, *performance highlights* occurred both during the intervention phase and in the posttest: "for me a highlight was now actually the intermediate exam" (Julia); "whoa, I found it fantastic today (laughs) (. . . .) and I was completely inside the character" (Lucy). Others mentioned that the *performance went well*, often despite adverse circumstances: "it was really crazy. But somehow it went well, like it's just, I didn't expect to" (Coco). Participants further expressed their satisfaction in describing how their *own expectations were met* by their positive performance experiences: "all what I had wished for, what I want to achieve with the monolog and after the training, exactly that I have accomplished today. (. . .) I'm one hundred percent satisfied" (Lucy); "so this was just pretty close to that ideal, what I just have there, or it was exactly that, how I actually wish it to be" (Tom).

However, not all performances were completely satisfying, as indicated by participants' *recognition of sub-par aspects*. They gave different reasons for why they performed less than desired and also alluded to the importance of context:

> Today was a chaotic day for me. And like physically I don't feel so good (. . .) just internally focused on the music and on the steps and trying not to focus on the pain and on the audience and additional stress. (. . .) And I felt really in it. I mean it wasn't perfect, there was some little things that could have been better, I think. (Coco)

Other aspects included intonation and technical issues, taking more time or preparing particular moments better and lacking artistic excellence: "it was not quite clean, that is of course a matter of practice, that the brilliance is a bit lower and it also does not sound so lively" (Julia). Participants justified sub-par performance with a lack of preparation or difficult circumstances or evaluated themselves worse when they were comparing the performance to previous, better ones. Going beyond artistic performance quality, participants also talked about satisfaction with progress in the psychological dimension of their performance: "and the performance like mentally, I am actually also really satisfied. I

have actually also managed that well" (Bianca); "so it is now more, perhaps one can then let one's body (…), let one's skills just do, one does not worry so much anymore" (Anne).

An important part of their performance evaluations concerned *feedback from others*, such as professors or members of the audience or jury. When participants were satisfied with their performance, positive feedback was perceived as encouraging or rewarding their effort: "when one gets praise from one's professors, also from non-accordionists, that/ and one sees, 'ah yes, it was then somehow worth it'. Crazy often for months, I would run into a wall when playing from memory. But then it somehow did work out" (Julia). Discrepancy between the inner and outer perspective was perceived as interesting or illuminating: "that the self-evaluation after playing sometimes diverges quite substantially from what one would say if one had watched oneself from the audience's perspective" (Tom). Others' feedback was described as frustrating when it differed from one's self-evaluation in a negative, but also in a positive way, especially when not seen as constructive. In terms of the performance experience itself, one's own perception might actually be more important, as expressed by Vivi: "that is then actually horrible for me to play, when I myself do not [perceive] it as beautiful".

With the theme *feeling good and enjoying performing*, we extend the idea that the artists' own experience may be crucial. We identified a pattern of emphasizing one's feelings against technical or artistic evaluations of one's performance. In particular, Vivi stated: "I somehow find it more important how I'm doing (…) when I feel good, then of course the audience feels good, too". On the one hand, *feeling comfortable* was explicitly related to a higher layer of experience: "I could listen relatively well to what I wanted to do and could divert a bit from this technical aspect (…) it is mainly that I now really had the feeling (…) that I can just make music" (Julia). On the other hand, feeling comfortable during the posttest was also described with different facets. Sometimes it was attributed to being more familiar with the situation: "I think I generally felt more comfortable (. …) also because I of course have already experienced the situation once, that naturally makes a difference" (Anne). Simultaneously to providing comfort, this familiarity also increased the pressure on some participants. Being aware of the comparability raised the expectation of performing substantially better than in the pretest: "I have put a bit more pressure on myself today, because I naturally, yeah, somehow just also wanted to show an improvement" (Bianca). Finally, when having to communicate dramatic emotions, feeling comfortable might even be counterproductive: "I was feeling very comfortable and I actually thought 'Oh dear, how should I play this monolog now? I'm in way too good a mood'" (Lucy).

Having fun was described as a particular way of enjoyment during the performance and related to a positive energy that was shared with one's ensemble or audience:

> At my concert it was truly like that, that I had really a lot of fun to play with the people (…) that also came like, as feedback from my fellow musicians, that they somehow also had fun and that it was a cool ambiance and energy. (Tom)

Fun and enjoyment were mentioned as distinct features of the posttest and were connected to being in the moment:

> At the first one I was like kind of 'okay let's sing it and let it be over. Let this moment to be over.' And today I was kind of more enjoying it. Like I could sing more, like I hold the last note. (Zoe)

Ultimately, enjoying the performance and being in the moment was connected to *flow experiences*, characterized by participants as being "simply completely in the zone" (Tom), "not thinking about doing it a certain way" (Coco), and "being rather than showing or doing" (Anne). For Lucy, this constituted her main goal for the coaching, and at the end, she reflected on its meaning:

> For me, everything culminates in being in the moment. And through the exercises, I've accomplished that now, so I would say, I have/when I have managed to be in the moment, then I have indeed also achieved something in the other steps.

3.4. Broader effects of the intervention

As a final theme, we identified *general positive effects of the intervention* that went beyond the effects outlined above. Enhanced motivation was explicitly mentioned as something participants took away from the coaching. For example, Zoe said:

> I get a lot of motivation. Like, not like 'okay let's get out of the bed and practice', not that. I mean I get motivation of singing again in shower, every moment of the day, and listening to music actually more, and enjoying it. Enjoying every noise that I'm hearing. So that was really nice. Thank you for that.

Participants were mostly content when looking back at the coaching process and their initial goals, but sometimes they also changed the goals themselves, which opened up new perspectives: "not to look for perfection or stability in every area, that 'now I'm prepared for everything', but also if I'm not prepared to something, that I can deal with it" (Coco). Using intervention strategies was described as effective and uplifting for how one talks to oneself, not just regarding performance, but also in everyday life: "I can deal better with agitation in general, or with the/ maybe also with thoughts or attitudes toward myself that are not helpful, but are in the way or rather hold back" (Anne). Indeed, being aware of one's ability to manage one's thoughts, feelings, and reactions, also through what was learned during the study, appeared as the main asset and take-home message:

> That I really feel like this, that I went from monochrome to full colors (. …) Like in almost every way when it comes to performing, like how my body reacts, how my mind is set up, how do I like interact with others, and this big calmness what is the current topic of mind, that's also coming, and that also changed my everyday. (Mia)

4. Discussion

In this study, we sought to illuminate the effects of tailored interventions on choking-susceptible performing artists'

performance quality, performance anxiety, fear of negative evaluation (FNE), and self-efficacy with a mixed-methods approach. Amidst variation both between and within individuals, both qualitative and quantitative data indicate a positive impact. This includes higher performance quality according to experts as well as participants, enhanced self-efficacy, and lower performance anxiety and FNE in the posttest. Thematic analysis of interviews and coaching sessions revealed that this progress was not always characterized by linear improvement: instead, some experienced struggles with intense nervousness and subsequent performance decrements, but also performance highlights earlier in the intervention phase that made the posttest seem less remarkable in comparison. The positive effects of the intervention were perceived not only in relation to cognitive, emotional, and behavioral aspects of performance, but also extended to participants' everyday lives.

Questionnaire and interview data appeared to show that participants had lower trait and state performance anxiety after the intervention period. During the intervention phase, however, some performances elicited strong anxiety. Participants were either able to manage their anxiety so that it did not negatively impact performance quality, or to learn from anxiety-provoking situations and thereby improve subsequent performances. Familiarity with the setting in the posttest created a more comfortable feeling, but at the same time also increased the pressure to perform even better than in the pretest. The relationship between perceived pressure of the situation and performance anxiety thus appears to be individual and context-dependent. Importantly, participants' interpretation of their anxiety symptoms, but also the controllability of these symptoms through psychological strategies, may be more important than their intensity.

The relevance of interpretation and controllability has been pointed out in previous studies with actors (Goodman and Kaufman, 2014), dancers (Walker and Nordin-Bates, 2010), and musicians (Clark and Williamon, 2011). These studies link feeling in control of one's anxiety to self-confidence and self-efficacy, but with different directions: feeling in control may be the result of raised self-confidence and subsequently foster facilitative interpretations of anxiety (Walker and Nordin-Bates, 2010), or feeling more in control of debilitating aspects of anxiety may lead to increases in self-efficacy (Clark and Williamon, 2011). Notably, the intervention by Clark and Williamon did not reduce musicians' performance anxiety, but it did enhance their self-efficacy. Participants in our study depicted anxiety management strategies as strengthening their self-confidence, as well as their self-efficacy for both dealing with their anxiety and performing well. In contrast, the reduction of FNE, as shown by both quantitative and qualitative data, appeared to have been grounded in participants' enhanced self-confidence and pride. Given the potential role of FNE in the relationship between self-presentation and choking (Mesagno et al., 2012), lowered FNE through increased self-confidence may be a particularly noteworthy outcome.

The enhancement of self-confidence became especially apparent in participants' descriptions of daring to do things they had not done before, and of being more aware and proud of being an artist. Exhibiting stronger identification and connection with one's art form after taking part in the study should also be seen in the context of the COVID-19 pandemic, during which performing artists were confronted with existential challenges (Spiro et al., 2021). Our study was conducted at a time when it became gradually possible again to perform, giving participants the opportunity to receive appreciation from an audience and reconnect with their profession and artistic identity.

Feedback from others was an important part of how participants saw their performance. Whereas unfounded feedback may cause anxiety, positive and constructive feedback may enhance self-confidence (Walker and Nordin-Bates, 2010). From the standpoint of self-efficacy theory, participants' successful performances may have represented mastery experiences that supported their self-efficacy for performing and subsequently facilitated satisfying performance experiences in the posttest (Bandura, 1997). Whereas previous research in music found that self-efficacy predicts performance quality (e.g., Ritchie and Williamon, 2012), their causal and bi-directional relationships have to be investigated more thoroughly.

For reasons of article length, it is not possible to discuss each participant's individual goals and interventions. However, some insights deserve mention. Remarkably, none of the participants set the goal of explicitly reducing anxiety, and only two of them wished for improved performance in the sense of being able to show on stage what they had prepared. Therefore, in addition to the choking interventions that have so far been beneficially applied by athletes, the tailored interventions in this study also included additional relaxation techniques to accommodate participants' requests for methods to help them sleep better or deal with excessive muscle tension. Imagery and self-talk also became relevant to improving performance from memory, enhancing video recordings for auditions, or facilitating emotional transitions between different parts of a show. Some participants also expressed the need for managing their post-performance emotions and arousal. These are examples of immediate and surrounding aspects of performance under pressure that appear to be of particular significance to choking-susceptible performing artists and could be helpful to inform future studies and interventions. The variety of requests and preferences also attest to the truly multifaceted nature of performance anxiety and the importance of taking an individualized approach.

Participants' accounts of enjoying performing and the general positive effects of the intervention also point toward a promising two-pronged approach for future interventions, adding the perspective of positive psychology and enhancement of flow to anxiety management. Indeed, such an intervention by Cohen and Bodner (2019) resulted in better performance and lower performance anxiety. Whereas they did not report changes in global or dispositional flow after the intervention, the authors argued that changes in flow state as a short-term experience after a performance may be more relevant and readily observable in relation to PST. Similarly, descriptions of flow states by our participants were connected to specific performance experiences. Therefore, participants' emphasis on being in the moment and the ability to let go, but maybe also accept certain thoughts and emotions, points further toward the relevance of ACT and ACC as a possible, alternative or complementary, way of intervening with choking-susceptible performing artists (Juncos and de Paiva e Pona, 2022).

4.1. Applied recommendations

Tailoring interventions to individual needs and goals appears to be a promising avenue for supporting performing artists who are strongly affected by their performance anxiety. Learning strategies for performance under pressure seemed to be relevant not only before, but also after performances, as well as for general stress management and wellbeing in their artistic everyday life. The most important recommendation is thus to let artists self-determine the implementation process of their tailored intervention. Occasionally, intervention strategies were discussed in the coaching sessions without subsequently being applied by participants, mainly because there was not enough time or even perceived necessity to do so. Allowing enough time for implementation and assisting in either finding situations to test out strategies or actively creating them, such as with acclimatization training, is therefore crucial for putting tailored interventions into practice. Even when performing artists feel restricted by their anxiety and are thus choking-susceptible, the focus of intervention may have to be directed more toward finding flow and being in the moment, especially when their own perceptions and emotional experience of the performance are more relevant to them than audience evaluations.

4.2. Strengths, limitations, and future research

This study is the first to investigate tailored interventions with choking-susceptible performing artists. The mixed-methods approach and the wealth of data collected for this study are its major strengths. That the first author, a psychologist, certified psychological coach, and trained violinist, both conducted coaching and interviews and analyzed the data, can be seen as a strength as well as a limitation. With her background in music and affinity to dance and acting, she was able to establish rapport with the participants and empathize with performance-related challenges, which may be vital for implementing sports-based interventions with performing artists (Pecen et al., 2016). Furthermore, she could use personal insights and profound knowledge of the data as assets for reflexive thematic analysis (Braun and Clarke, 2021). At the same time, her involvement likely shaped how participants evaluated the interventions' outcomes, and the way she approached the analysis.

The individual, person-based tailoring approach may provide benefits for performing artists but also makes direct replication impossible. We conceptualized this study as a collective case study in order to explore such a tailored approach and its effects. The lack of replicability is a weakness that we believe is somewhat inherent in our approach. A detailed analysis of how the first author as coach tailored interventions to participants' goals or expressed needs was not included in this article for reasons of article length, but might be an interesting subject of future research. Furthermore, we would like to differentiate our approach (i.e., having a psychologist deliver tailored interventions within an individual coaching setting) from PST and ACC programs delivered in group settings by performing arts educators without specialized psychological training (Gill, 2020; Shaw et al., 2020; Mahony et al., 2022). Future studies might thus be focused on whether or how performing arts educators can be trained to tailor such interventions specifically to performing artists' individual needs.

Because not all the originally selected artists were able to participate, and because the distribution in the population invited to participate was uneven between music, dance, and acting, the three domains were not equally represented. In addition, some participants did not meet all three quantitative selection criteria. Future studies may benefit from recruiting choking-susceptible participants from a larger pool of performing artists. That some of those originally chosen withdrew their participation was also due to the unique situation during recruitment: performances were finally possible again after over a year with several lockdowns. This situation should be considered when looking at the results: a certain enthusiasm, but also overexcitement about being on stage again may have been due to the contrast to previous restrictions.

Furthermore, the sample would be too small for a purely quantitative study. With the data of nine persons, we had 70% power to observe a large effect of $d_z = 0.8$, indicating that larger samples should be used in future studies that mainly focus on quantitative effects. In terms of performance quality, budget restrictions and the extensive amount of video material meant that each participant was only evaluated by one expert in their respective field. Future studies may include several raters per performance to ensure higher reliability of performance evaluations.

There is recent evidence that repeated performance exposure can significantly reduce HR and anxiety-related non-artistic performance errors (Candia et al., 2023). Not having included control cases might be seen as a limitation for the quantitative analysis, yet we could not conceive of an adequate control condition for our extensive design. We, therefore, emphasize that the outcomes may not be exclusively attributable to our intervention. In addition, future studies may take into account context-specific factors that could influence performing artists' perceptions of their environment (Miller and Chesky, 2004).

Finally, causal effects may be difficult to disentangle, even for the participants themselves. Some participants noted that it was hard to understand which specific effect could be attributed to the intervention: "always difficult to find out for oneself, what is why and how, because yeah one does not really have a suitable comparison" (Tom). Therefore, the causal effects of the interventions cannot always be implied. Future research might investigate possible underlying causes and mechanisms along with artists' abilities in applying psychological skills, and not just focus on the outcomes of an intervention.

5. Conclusion

This study strengthens the bridges between different performing arts as well as between performing arts and sport

psychology. Our data demonstrate that tailored interventions inspired by sport psychology can have a positive impact on choking-susceptible performing artists' anxiety, self-efficacy, performance quality, and even their everyday lives. In our view, the qualitative data particularly emphasize the importance of individual context. Whether an intervention can be considered beneficial also depends on the perspective taken: is it more relevant to improve the artist's or the audience's satisfaction with the artistic quality of the performance, or perhaps just artists' own emotional experiences while performing? Future research should thus be extended to the investigation of long-term effects and underlying mechanisms of tailored interventions, potentially with a stronger focus on how the interventions are being implemented and what role the relationship during coaching plays.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Review Board of the Department of Work, Economy, and Social Psychology, Faculty of Psychology, University of Vienna. The patients/participants provided their written informed consent to participate in this study.

Author contributions

VL and PG conceptualized, designed, and conducted the study. VL implemented the interventions and wrote the first draft. SN-B conceptualized the qualitative analysis. PG and SN-B wrote sections of the manuscript. All authors contributed to data analyses and manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1164273/full#supplementary-material

References

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control.* New York: W.H. Freeman and Company.

Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *J. Personal. Soc. Psychol.* 46, 610–620. doi: 10.1037/0022-3514.46.3.610

Beckmann, J., Gröpel, P., and Ehrlenspiel, F. (2013). Preventing motor skill failure through hemisphere-specific priming: Cases from choking under pressure. *J. Exper. Psychol.* 142, 679–691. doi: 10.1037/a0029852

Braden, A. M., Osborne, M. S., and Wilson, S. J. (2015). Psychological intervention reduces self-reported performance anxiety in high school music students. *Front. Psychol.* 6, 195. doi: 10.3389/fpsyg.2015.00195

Braun, V., and Clarke, V. (2021). *Thematic Analysis: A Practical Guide.* Victoria–London: Sage.

Byrne, A., and Eysenck, M. W. (1995). Trait anxiety, anxious mood, and threat detection. *Cogn. Emot.* 9, 549–562. doi: 10.1080/02699939508408982

Candia, V., Kusserow, M., Margulies, O., and Hildebrandt, H. (2023). Repeated stage exposure reduces music performance anxiety. *Front. Psychol.* 14, 1146405. doi: 10.3389/fpsyg.2023.1146405

Carleton, R. N., McCreary, D. R., Norton, P. J., and Asmundson, G. J. (2006). Brief fear of negative evaluation scale-revised. *Depress Anxiety.* 23, 297–303.

Chang-Arana, Á. M., Kenny, D. T., and Burga-León, A. A. (2018). Validation of the Kenny Music Performance Anxiety Inventory (K-MPAI): A cross-cultural confirmation of its factorial structure. *Psychol. Music* 46, 551–567. doi: 10.1177/0305735617717618

Clark, T., and Williamon, A. (2011). Evaluation of a mental skills training program for musicians. *J. Appl. Sport Psychol.* 23, 342–359. doi: 10.1080/10413200.2011.574676

Cohen, S., and Bodner, E. (2019). Music performance skills: A two-pronged approach – facilitating optimal music performance and reducing music performance anxiety. *Psychol. Music* 47, 521–538. doi: 10.1177/0305735618765349

Cotterill, S. (2010). Pre-performance routines in sport: Current understanding and future directions. *Int. Rev. Sport Exer. Psychol.* 3, 132–153. doi: 10.1080/1750984X.2010.488269

Cotterill, S., Sanders, R., and Collins, D. (2010). Developing effective pre-performance routines in golf: Why don't we ask the golfer? *J. Appl. Sport Psychol.* 22, 51–64. doi: 10.1080/10413200903403216

Easton, G. (2010). Critical realism in case study research. *Ind. Market. Manage.* 39, 118–128. doi: 10.1016/j.indmarman.2008.06.004

Gill, A. (2020). *Enhancing music performance self-efficacy through psychological skills training* [Doctoral dissertation, University of Melbourne]. Melbourne Conservatorium of Music - Theses.

Goodman, G., and Kaufman, J. C. (2014). Gremlins in my head: Predicting stage fright in elite actors. *Empir. Stud. Arts* 32, 133–148. doi: 10.2190/EM.32.2.b

Greene, D. J. (2002). *Performance Success: Performing Your Best Under Pressure.* New York: Routledge.

Gröpel, P., and Mesagno, C. (2019). Choking interventions in sports: A systematic review. *Int. Rev. Sport Exer. Psychol.* 12, 176–201. doi: 10.1080/1750984X.2017.1408134

Hanton, S., Mellalieu, S. D., and Hall, R. (2004). Self-confidence and anxiety interpretation: A qualitative investigation. *Psychol. Sport Exer.* 5, 477–495. doi: 10.1016/S1469-0292(03)00040-2

Hatfield, J. L. (2016). Performing at the top of one's musical game. *Front. Psychol.* 7, 1356. doi: 10.3389/fpsyg.2016.01356

Hatfield, J. L., and Lemyre, P. N. (2016). Foundations of intervention research in instrumental practice. *Front. Psychol.* 6, 2014. doi: 10.3389/fpsyg.2015.02014

Hays, K. F. (2017). "Performance Psychology with Performing Artists," in *Oxford Research Encyclopedia of Psychology*. doi: 10.1093/acrefore/9780190236557.013.191

Henze, G. I., Zänkert, S., Urschler, D. F., Hiltl, T. J., Kudielka, B. M., Pruessner, J. C., et al. (2017). Testing the ecological validity of the Trier Social Stress Test: Association with real-life exam stress. *Psychoneuroendocrinology* 75, 52–55. doi: 10.1016/j.psyneuen.2016.10.002

Hodge, K., and Sharp, L.-A. (2019). "Case studies," in *Routledge handbook of qualitative research in sport and exercise,* eds. B. Smith and A. C. Sparkes (London: Routledge) 62–74.

Hoffman, S. L., and Hanrahan, S. J. (2012). Mental skills for musicians: Managing music performance anxiety and enhancing performance. *Sport, Exer. Perform. Psychol.* 1, 17–28. doi: 10.1037/a0025409

Juncos, D. G., and de Paiva e Pona, E. (2022). *ACT for musicians: A guide for using acceptance and commitment training to enhance performance, overcome performance anxiety, and improve well-being.* Universal Publishers.

Juncos, D. G., and Markman, E. J. (2016). Acceptance and commitment therapy for the treatment of music performance anxiety: A single subject design with a university student. *Psychol. Music* 44, 935–952. doi: 10.1177/0305735615596236

Kageyama, N. J. (2007). *Attentional focus as a mediator in the anxiety-performance relationship: The enhancement of music performance quality under stress (Publication No. 3297078)* [Doctoral dissertation, Indiana University]. ProQuest Dissertations and Theses Global.

Kenny, D. T. (2011). *The Psychology of Music Performance Anxiety*. London: Oxford University Press. doi: 10.1093/acprof:oso/9780199586141.001.0001

Kinne, A. (2016). *The impact of a mental skills training program on music students' performance anxiety and self-efficacy* (Publication No. 10144202) [Doctoral dissertation, Indiana University]. ProQuest Dissertations and Theses Global.

Kirschbaum, C., Pirke, K. M., and Hellhammer, D. H. (1993). The 'Trier Social Stress Test'–a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology* 28, 76–81. doi: 10.1159/000119004

Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *Sport Psychol.* 8, 189–202. doi: 10.1123/tsp.8.2.189

Kubzansky, L. D., and Stewart, A. J. (1999). At the intersection of anxiety, gender, and performance. *J. Soc. Clin. Psychol.* 18, 76–97. doi: 10.1521/jscp.1999.18.1.76

Kuckartz, U. (2014). *Mixed Methods: Methodologie, Forschungsdesigns und Analyseverfahren.* Berlin: Springer-Verlag. doi: 10.1007/978-3-531-93267-5

Lidor, R., and Mayan, Z. (2005). Can beginning learners benefit from preperformance routines when serving in volleyball? *Sport Psychol.* 19, 343–363. doi: 10.1123/tsp.19.4.343

Low, W. R., Sandercock, G. R. H., Freeman, P., Winter, M. E., Butt, J., and Maynard, I. (2021). Pressure training for performance domains: A meta-analysis. *Sport, Exer. Perform. Psychol.* 10, 149–163. doi: 10.1037/spy0000202

Lubert, V. J., and Gröpel, P. (2022). Testing interventions for music performance under pressure: A randomized controlled study. *Sport, Exer. Perform. Psychol.* 11, 93–105. doi: 10.1037/spy0000285

Mahony, S. E., Juncos, D. G., and Winter, D. (2022). Acceptance and commitment coaching for music performance anxiety: Piloting a 6-week group course with undergraduate dance and musical theatre students. *Front. Psychol.* 13, 830230. doi: 10.3389/fpsyg.2022.830230

Mesagno, C., and Beckmann, J. (2017). Choking under pressure: Theoretical models and interventions. *Curr. Opin. Psychol.* 16, 170–175. doi: 10.1016/j.copsyc.2017.05.015

Mesagno, C., Ehrlenspiel, F., Wergin, V., and Gröpel, P. (2021). "Choking under pressure," in *Sport, Exercise and Performance Psychology: Research Directions to Advance the Field,* eds. E. Filho and I. Basevitch (London: Oxford University Press) 31–45. doi: 10.1093/oso/9780197512494.003.0003

Mesagno, C., Harvey, J. T., and Janelle, C. M. (2012). Choking under pressure: The role of fear of negative evaluation. *Psychol. Sport Exer.* 13, 60–68. doi: 10.1016/j.psychsport.2011.07.007

Mesagno, C., Marchant, D., and Morris, T. (2008). A pre-performance routine to alleviate choking in "choking-susceptible" athletes. *Sport Psychol.* 22, 439–457. doi: 10.1123/tsp.22.4.439

Mesagno, C., Marchant, D., and Morris, T. (2009). Alleviating choking: The sounds of distraction. *J. Appl. Sport Psychol.* 21, 131–147. doi: 10.1080/10413200902795091

Mesagno, C., Mornell, A., and Quinn, A. L. (2016). "Choking under pressure in sport and music: Exploring the benefits of theory transfer across domains," in *Art in motion III. Performing under pressure,* eds. A. Mornell (Peter Lang) 23–57.

Miller, S. R., and Chesky, K. (2004). The multidimensional anxiety theory: An assessment of and relationships between intensity and direction of cognitive anxiety, somatic anxiety, and self-confidence over multiple performance requirements among college music majors. *Med. Problems Perfor. Artists* 19, 12–20. doi: 10.21091/mppa.2004.1003

Moran, A. P. (1996). *The Psychology of Concentration in Sport Performers: A Cognitive Analysis.* London: Psychology Press.

Osborne, M. S., Greene, D. J., and Immel, D. T. (2014). Managing performance anxiety and improving mental skills in conservatoire students through performance psychology training: a pilot study. *Psychol. WellBeing.* 4, 18. doi: 10.1186/s13612-014-0018-3

Pecen, E., Collins, D., and MacNamara, Á. (2016). Music of the night: Performance practitioner considerations for enhancement work in music. *Sport, Exer. Perform. Psychol.* 5, 377–395. doi: 10.1037/spy0000067

Pruessner, J. C., Kirschbaum, C., Meinlschmid, G., and Hellhammer, D. H. (2003). Two formulas for computation of the area under the curve represent measures of total hormone concentration versus time-dependent change. *Psychoneuroendocrinology* 28, 916–931. doi: 10.1016/S0306-4530(02)00108-7

Reichenberger, J., Schwarz, M., König, D., Wilhelm, F. H., Voderholzer, U., Hillert, A., et al. (2016). Angst vor negativer sozialer Bewertung: Übersetzung und Validierung der Furcht vor negativer Evaluation – Kurzskala. *Diagnostica* 62, 169–181. doi: 10.1026/0012-1924/a000148

Ritchie, L., and Williamon, A. (2012). Self-efficacy as a predictor of musical performance quality. *Psychol. Aesthetics, Creat. Arts* 6, 334–340. doi: 10.1037/a0029619

Rupprecht, A. G. O., Tran, U. S., and Gröpel, P. (2021). The effectiveness of pre-performance routines in sports: a meta-analysis. *Int. Rev. Sport Exer. Psychol.* 2021, 1–26. doi: 10.1080/1750984X.2021.1944271

Salmon, P. G. (1990). A psychological perspective on musical performance anxiety: A review of the literature. *Med. Problems Perform. Artists* 5, 2–11.

Schlotz, W., Schulz, P., Hellhammer, J., Stone, A. A., and Hellhammer, D. H. (2006). Trait anxiety moderates the impact of performance pressure on salivary cortisol in everyday life. *Psychoneuroendocrinology* 31, 459–472. doi: 10.1016/j.psyneuen.2005.11.003

Schwarzer, R., and Jerusalem, M. (1995). "Generalized Self-Efficacy scale," in *Measures in health psychology: A user's portfolio. Causal and control beliefs,* J. Weinman, S. Wright, and M. Johnston (NFER-NELSON) 35–37. doi: 10.1037/t00393-000

Schwarzer, R., and Jerusalem, M. (2003). *SWE. Skala zur Allgemeinen Selbstwirksamkeitserwartung* [Verfahrensdokumentation, Autorenbeschreibung und Fragebogen]. In Leibniz-Institut für Psychologie (ZPID) (Hrsg.), Open Test Archive. Trier: ZPID.

Seddon, J. A., Rodriguez, V. J., Provencher, Y., Raftery-Helmer, J., Hersh, J., Labelle, P. R., et al. (2020). Meta-analysis of the effectiveness of the Trier Social Stress Test in eliciting physiological stress responses in children and adolescents. *Psychoneuroendocrinology* 116, 104582. doi: 10.1016/j.psyneuen.2020.104582

Shaw, T. A., Juncos, D. G., and Winter, D. (2020). Piloting a new model for treating music performance anxiety: Training a singing teacher to use acceptance and commitment coaching with a student. *Front. Psychol.* 11, 882. doi: 10.3389/fpsyg.2020.00882

Simons, H. (2009). *Case Study Research in Practice*. London: Sage Publications. doi: 10.4135/9781446268322

Skvarla, L. A., and Clement, D. (2019). The delivery of a short-term psychological skills training program to college dance students: a pilot study examining coping skills and injuries. *J. Dance Med. Sci.* 23, 159–166. doi: 10.12678/1089-313X.23.4.159

Smith, B., and McGannon, K. R. (2018). Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. *Int. Rev. Sport Exer. Psychol.* 11, 101–121. doi: 10.1080/1750984X.2017.1317357

Spahn, C., Walther, J.-C., and Nusseck, M. (2016). The effectiveness of a multimodal concept of audition training for music students in coping with music performance anxiety. *Psychol. Music* 44, 893–909. doi: 10.1177/0305735615597484

Sparkes, A. C. (2015). Developing mixed methods research in sport and exercise psychology: Critical reflections on five points of controversy. *Psychol. Sport Exer.* 16, 49–59. doi: 10.1016/j.psychsport.2014.08.014

Spiro, N., Perkins, R., Kaye, S., Tymoszuk, U., Mason-Bertrand, A., Cossette, I., et al. (2021). The effects of COVID-19 lockdown 1.0 on working patterns, income, and wellbeing among performing arts professionals in the United Kingdom (April–June 2020). *Front. Psychol.* 11, 594086. doi: 10.3389/fpsyg.2020.594086

Stake, R. E. (1998). "Case studies," in *Strategies of qualitative inquiry,* eds. N. K. Denzin and Y. S. Lincoln (London: Sage Publications) 86–109.

Tief, V. J., and Gröpel, P. (2021). Pre-performance routines for music students: An experimental pilot study. *Psychol. Music* 49, 1261–1272. doi: 10.1177/0305735620953621

Walker, I. J., and Nordin-Bates, S. M. (2010). Performance anxiety experiences of professional ballet dancers: The importance of control. *J. Dance Med. Sci.* 14, 133–145.

Wang, J., Marchant, D. B., Morris, T., and Gibbs, P. (2004). Self-consciousness and trait anxiety as predictors of choking in sport. *J. Sci. Med. Sport.* 7, 174e185. doi: 10.1016/S1440-2440(04) 80007-0

Weinberg, R. S., and Butt, J. (2014). "Goal-setting and performance," in *Routledge companion to sport and exercise psychology: Global perspectives and fundamental concepts,* eds. A. Papaioannou, and D. Hackfort (New York: Routledge Ltd.) 343–355.

Williamson, O., Swann, C., Bennett, K. J., Bird, M. D., Goddard, S. G., Schweickle, M. J., et al. (2022). The performance and psychological effects of goal setting in sport: A systematic review and meta-analysis. *Int. Rev. Sport Exer. Psychol.* 2022, 1–29. doi: 10.1080/1750984X.2022.2116723

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The *Kenny music performance anxiety inventory* (K-MPAI): Scale construction, cross-cultural validation, theoretical underpinnings, and diagnostic and therapeutic utility

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I commenced my academic exploration of music performance anxiety in a study with opera chorus artists from Opera Australia in 2004. I subsequently postulated a new theory of the aetiology of music performance anxiety and began the development of the *Kenny Music Performance Anxiety Inventory* (K-MPAI) to assess the hypothesized theoretical constructs underpinning its diverse clinical presentations. I proposed a new definition of music performance anxiety in 2009 and revised the item content of the K-MPAI from 26 to 40 in 2011. Over the ensuing years, many researchers have used the K-MPAI in studies on a wide variety of musicians, including vocalists and instrumentalists, popular and classical musicians, tertiary music students, and professional, solo, orchestral, ensemble, band, and community musicians. To date, the K-MPAI has been reported in more than 400 studies and has been translated into 22 languages. It has been the subject of more than 39 dissertations. In this paper, I examine the research that has used the K-MPAI to assess the theory and to ascertain how well the assessment tool, and its cross-cultural validation have provided evidence for its factorial structure, robustness, and utility. The evidence indicates that the factorial structure remains consistent across cultures and different populations of musicians. It has good discriminative ability and utility for diagnostic purposes. I conclude with some reflections on how the K-MPAI can guide therapeutic interventions and with some thoughts on future directions.

KEYWORDS

Kenny music performance anxiety inventory, music performance anxiety, musicians, cross-cultural validation, factor structure, performance psychology

1. Construction of the *Kenny music performance anxiety inventory* (K-MPAI)

> *Nothing is more devastating to a performing artist than not having the chance to be on stage and, as the pervasiveness of performance anxiety attests, nothing is more threatening than having that chance* (Plaut, 1990).

The *Kenny Music Performance Anxiety Inventory* (K-MPAI; Kenny, 2009) is a 40-item inventory that assesses an emotion-based theory of anxiety (Barlow, 2000, 2004) as it applies to

anxiety in the context of music performance. Items address each of Barlow's theoretical constructs that underpin anxiety–evocation of anxious propositions (e.g., uncontrollability, unpredictability, negative affect, situational cues); attentional shift (e.g., task or self-evaluative focus, fear of negative evaluation); physiological arousal, and memory. Items are assessed using a seven-point Likert scale, with higher scores indicating more severe MPA and psychological distress generally (including depression).

The first studies of the factorial structure of the K-MPAI were undertaken with 379 professional orchestral musicians in Australia and 159 tertiary music students in New Zealand. For the orchestral musicians, exploratory factor analysis with varimax rotation produced six factors–proximal somatic anxiety and worry about performance (α= 0.91); worry/dread (negative cognitions/ruminations) focused on self/other scrutiny (α= 0.86); depression/hopelessness (psychological vulnerability)(α = 0.85); parental empathy (α= 0.75); concerns with memory (α = 0.92); generational transmission of anxiety (α = 0.72); an additional weaker factor – anxious apprehension (α = 0.59); and one item for biological vulnerability (Kenny et al., 2012). For the tertiary level music students, Cronbach's alpha for internal consistency (α) was 0.94 (Kenny, 2009). There were 12 underlying factors, which could be subsumed under the following three meta-factors: 1. Early relationship context: (7) generational transmission of anxiety; (4) parental empathy]; 2. Psychological vulnerability: [(1) depression/hopelessness (9); controllability; (11) trust (12); pervasive performance anxiety]; and 3. Proximal performance concerns: [(3) proximal somatic anxiety; (2) worry/dread (negative cognitions); (6) pre- and post-performance rumination; (8) self/other scrutiny; (10) opportunity cost; (5) memory reliability] (Kenny, 2011).

Receiver operating curves were generated using established clinical screening tests [State–Trait Anxiety Inventory – Trait (STAI-T) (Spielberger, 1983), PRIME-MD (Spitzer et al., 2003), Social Phobia Inventory (SPIN) (Connor et al., 2000)] validated in clinical populations to identify clinical cut-off scores for the K-MPAI. The cut-point for K-MPAI using Youden's Index for STAI-T ≥ 65 (1.5 SD above mean) was 105.3; for STAI-T ≥ 60 (1 SD above mean), Youden's Index for K-MPAI was 104.5. For musicians answering yes to both depression questions on the PRIME-MD, the K-MPAI cut-point was 118.5; if they answered "yes" to one of two questions, K-MPAI cut-point was 110. As previously identified, K-MPAI and SPIN were unrelated (Kenny, 2016a).

The K-MPAI has been used in studies of tertiary level music students (e.g., Kenny et al., 2013; Paliaukiene et al., 2018; Rauf and Laitf, 2018; Oh et al., 2020); amateur musicians (Barbar et al., 2015); community musicians (Kenny and Halls, 2018); school band directors (Yoder, 2022); ensemble musicians (Robson and Kenny, 2017); elite orchestral musicians (Kenny et al., 2012, 2016, 2018; Kenny and Ackermann, 2015), opera chorus artists (Kenny et al., 2004); popular musicians (Bober, 2019); and Indian rock musicians (Meitei and Kumari, 2014).

The K-MPAI has also been modified for use with performers in fields other than music (Kantor-Martynuska and Kenny, 2018). In this study, the Polish translation of the K-MPAI was modified and named the *Kenny Performance Anxiety Inventory* (K-PAI). On a sample of 586 performing artists, the performance of the K-PAI was assessed using measures of general anxiety, depression, attentional control, and reward susceptibility. The scores on K-PAI revealed strong associations with trait anxiety and depression and negative associations with attentional control and susceptibility to reward. These results replicated those obtained on the K-MPAI with Australian musicians, indicating the cross-cultural validity of the K-MPAI and K-PAI. We concluded that performance anxiety develops on the basis of biological and psychological predispositions and early negative experiences in performance contexts.

The K-MPAI has been translated into 22 languages–Brazilian Portuguese (Rocha et al., 2011), Croatian (Ružak, 2021; Eva Stevanovic, 2022, personal communication), Czech (Eva Stevanovic, 2022, personal communication; Pavel Husa Fel, 2022, personal communication), Dutch (van Fenema et al., 2017), French (Antonini Philippe et al., 2022b), German (Peschke and von Georg, 2015), Hungarian (Dobos et al., 2019), Indonesian (Haninditya, 2021), Italian (Antonini Philippe et al., 2022a), Japanese (Sakie Takagi, Michiko Yoshie, Akihiko Murai, 2023 Korean (Oh et al., 2020), Latvian (Solveiga Sofija Saulīte, 2022, personal communication), Lithuanian (Paliaukiene and Kairys, 2012), Mandarin (Simplified Chinese) (Diana Wu, personal communication, Cancan Cui, personal communication); Persian (Fakhr, 2020; Kbodadadeh et al., 2022), Polish (Kantor-Martynuska and Kenny, 2018), Portuguese (Rocha et al., 2011), Slovenian Kaja Pojbič, Ana Gregorec, Urban Stiberc and Zala Brecko (personal communication, 2022), Spanish (also for Peru) (Chang-Arana, 2015; Zarza-Alzugaray et al., 2015; Chang-Arana, 2017; Chang-Arana et al., 2018), Taiwanese (Lin, 2019), Romanian (Faur et al., 2021), Turkish (Rocha et al., 2011; Çiçek and Güdek, 2020), and Ukrainian (Ksondzyk, 2020). I am advised that a Finnish translation is currently in preparation. All currently translations of the K-MPAI are available in Supplementary material. To date, the K-MPAI has been the subject of around 400 studies (see Supplementary material), and 39 doctoral dissertations were located (Note: This may not be an exhaustive list) (see Supplementary material for available translations).

2. Cross-cultural validation of the K-MPAI

In this review, I have excluded those studies that did not use the K-MPAI in a standardized way, for example, by pre-selecting items to shorten the questionnaire without explanation for item choice, or that have altered the K-MPAI in some way, for example, by changing the seven-point Likert scale to a dichotomous category (Always/Never) (Kbodadadeh et al., 2022). Sadly, I also could not include studies in most languages other than English that did not provide an abstract or summary in English or French. These are studies that could benefit from English-language translation to make their findings more widely available.

Some studies have used the 26-item version of the K-MPAI (e.g., Barbar et al., 2015; Zarza-Alzugaray et al., 2015; Casanova et al., 2018; Ksondzyk, 2020; Mancin et al., 2022), and although not directly comparable to the 40-item version, make important contributions. For example, Barbar et al. (2015), using a Portuguese Brazilian translation of the K-MPAI of the 26-item version with 230 graduate or undergraduate level amateur musicians (58% female; mean age = 39.17 years – SD = 16.48) and exploratory factor analysis, identified three factors that together accounted for 62% of the total shared variance. These were 1. Worries and insecurity (α = 0.82), 2. Depression and hopelessness (α = 0.77), and 3. Early parental

relationships ($\alpha = 0.57$). These themes repeatedly recur in subsequent studies using the 40-item version. In the 26-item version, items were specifically chosen to assess each of the three dimensions of Barlow's emotion-based theory (Kenny, 2009).

(i) Biological vulnerability predispositions (e.g., Behavioral inhibition, autonomic reactivity) and early contextual/parental vulnerabilities: items 5, 9, 19, 21, 24
(ii) Generalized psychological vulnerability: items 1, 2, 3, 4, 6, 8, 10, 11, 15, 16, 17, 18, 23
(iii) Specific triggering factors causing subsequent concerns about performance: items 7, 12, 13, 14, 20, 22, 25, 26.

The 40-item version retains this structure while enhancing some of these dimensions with the Addition 14 items.

After studies confirmed the validity of the English and Spanish versions of the K-MPAI (Chang-Arana, 2015; Chang-Arana, 2017), further exploration of the factorial structure was undertaken, applying higher order exploratory factor analysis (HOEFA) and an invariance analysis (Chang-Arana et al., 2018). Participants were 455 Peruvian tertiary music students, 74% male, mean age 21.19 years (SD = 3.13; range = 18–40 years) and the Australian sample of orchestral musicians described above, of whom 40% were male, mean age 42.07 years (SD = 10.21, range = 18–68 years). The model identified two first order factors–1. Music performance anxiety ($\alpha = 0.91$) and 2. Depression ($\alpha = 0.81$)–and one higher order factor that we named "negative affectivity in relation to music performance ($\alpha = 0.92$)." These three factors explained 59% of common shared variance. The invariance analysis demonstrated similar structure and interpretation of K-MPAI scores in both populations despite their cultural, age, and musical status differences. The factorial structure obtained supported a unidimensional interpretation of the construct of MPA related to negative affectivity (depression), not anxiety. This study provides compelling support for Kenny's theoretical conceptualization of MPA as a complex psychological disorder particularly for those musicians experiencing more severe forms of MPA.

Recently, several studies have been published that further explore the factorial structure of the K-MPAI in various populations and languages. Table 1 provides a summary of the outcomes of this research. Most have provided confirmation of the factorial structure of the K-MPAI found in English-speaking musicians and strong support for the underlying theoretical structure on which the inventory was constructed.

Content, construct, convergent, and discriminative validity, and clinical utility of the Spanish, Portuguese, and Portuguese Brazilian adaptations of the K-MPAI have been demonstrated in studies of Brazilian (Rocha et al., 2011; Barbar et al., 2014a, 2015), Spanish (Zarza-Alzugaray et al., 2015; Casanova et al., 2018), Portuguese (Dias et al., 2022), and Peruvian (Chang-Arana, 2015) musicians. Rocha et al. (2011) using the Brazilian Portuguese translation of K-MPAI with 218 professional and amateur musicians from Brazil, reported very high internal consistency for the K-MPAI ($\alpha = 0.98$), and a correlation of 0.64 with STAI-T. Most studies showed good convergent validity with other depression and anxiety scales used in general populations. Similarly, Chang-Arana et al. (2018) reported correlations between K-MPAI and STAI-Trait scores, $r = 0.70$, results that are comparable with English-speaking musicians. Two studies reported temporal stability, finding good test–test reliability for the K-MPAI ($r = 0.87$, $p < 0.001$; Ksondzyk, 2020; Mancin et al., 2022). One study also demonstrated sex invariance in the factorial structure of the K-MPAI (Mancin et al., 2022).

The K-MPAI also discriminated between music students with and without a prior history of anxiety disorders in addition to MPA (Figueiredo, 2020; Dias et al., 2022). Similarly, Wiedemann et al. (2022) showed that tertiary music students with a pathological anxiety profile consistently showed clinically relevant levels of MPA as assessed by the K-MPAI. Using a sample of 258 students from the Lithuanian Academy of Music and Theater, (65% female; mean age = 21.6, SD = 3.3, range 18 to 54 years), Paliaukiene et al. (2018) reported that students with the highest K-MPAI scores had the poorest academic achievement and the fewest number of concerts performed in the year of the study. Casanova et al. (2018), using a sample of 476 students studying for *Grado Superior de Música* in five Spanish music schools (47% female, mean age = 22.59, SD = 4.73, range 16 to 50 years) reported increasingly higher scores on K-MPAI over 4 years of study for soloists, with first year students showing less MPA than final year students, but found no such differences for students training for orchestral positions. K-MPAI has also been used to assess treatment outcomes, showing good sensitivity to effective treatment interventions (e.g., Juncos et al., 2017; Juncos and De Paivae Pona, 2018; Jelen, 2021).

3. Theoretical and clinical conceptualizations of MPA

Most of the theoretical concepts that I have applied to my understanding of MPA, its assessment and treatment have been derived from my clinical work with anxious musicians, my cognate disciplines of developmental psychology and developmental psychopathology, and my understanding and application of both cognitive behavioral therapies and psychodynamic psychotherapies, particularly attachment-informed and intensive short term dynamic psychotherapy. A psychodynamic understanding of MPA posits that the performance situation stirs conflicting unconscious desires, wishes, and tensions. The audience has a pivotal role in this process because of "the universal propensity of performers to experience an audience as though it were a person from childhood, real or imagined" (Weisblatt, 1986). As is the case for all causes of anxiety, music performance anxiety in its severe form is multi-determined.

Music psychology related to MPA was still in its infancy in the last century. Prior to 1994, performance anxiety was not included in the classificatory systems of psychological or psychiatric disorders. In the DSM-IV (APA, 1994) and DSM-IV-TR (APA, 2000) performance anxiety is briefly discussed in a section on differential diagnosis in social phobia. It was therefore necessary to stand on the shoulders of the giants of anxiety research in the psychological literature (e.g., Barlow, 2004) in order to formulate my theory and typology of MPA quality and severity. This formulation challenged the prevailing view that music performance anxiety (MPA) was a subtype of social anxiety (social phobia) (discussed below). It also challenged the view that MPA was a unidimensional construct occurring on a continuum of severity from career stress at the low end to stage fright at the high end (Brodsky, 1996). I argued that MPA is better understood as a typology

TABLE 1 Cross-cultural studies of the factor analysis of the KMPAI.

Authors	Language	Sample	Reliability	Factors	Variance explained	Items excluded (criterion for exclusion)
Antonini Philippe et al. (2022a)	Italian	419 music conservatoire students, 47% female, mean age = 23.18 years, SD = 5.26; range = 18–38 years	EFA $\alpha = 0.93$	1. Music performance anxiety symptoms ($\alpha = 0.93$) 2. Depression and hopelessness ($\alpha = 0.86$) 3. Parental support ($\alpha = 0.69$) 4. Memory self-efficacy ($\alpha = 0.89$) 5. Generational transmission of anxiety ($\alpha = 0.79$)	46%	2,7,8,24,27,39 (factor loading<0.4)
Antonini Philippe et al. (2022b)	French	211 music students from music schools and colleges in French-speaking Switzerland, 55% female, mean age = 25.34 years, SD = 9.58 (range16-65 years).	CFA $\alpha = 0.91$	1. Proximal somatic and cognitive anxiety ($\alpha = 0.87$) 2. Self/other scrutiny and evaluation ($\alpha = 0.78$) 3. Psychological vulnerability ($\alpha = 0.80$) 4. Confidence in memory ($\alpha = 0.78$) 5. Early parental relationship context ($\alpha = 0.61$)	39%	2, 5, 8, 11, 17, 28, 29, 32,40 (factor loading<0.3)
Dias et al. (2022)	Portuguese Portugal	164 undergraduate music students in Portugal (62.2% female; mean age = 22.63; SD = 4.36)	EFA $\alpha = 0.91$	1. Music performance anxiety-related symptoms 2. Depression and hopelessness 3. Parental support 4. Memory self-efficacy	51%	1,2,5,7,8,17,29,31,32,39,40
Mancin et al. (2022)	Italian 26 items	319 music performers 28% female, mean age = 25.51; SD = 8.1(range 8 and 62 years)	EFA CFA ($\alpha = 0.87$)	1. Proximal performance concerns ($\omega = 0.86$) 2. Helplessness – psychological vulnerability ($\omega = 0.86$) 3. Early parental context and memory reliance ($\omega = 0.80$)	40%	2,7,8
Faur et al. (2021)	Romanian	420 musicians, 48% female, mean age = 24.46, SD = 7.36 (range = 18–66 years)	EFA ($\alpha = 0.91$)	1. Music performance anxiety-related symptoms ($\alpha = 0.93$) 2. Parental support ($\alpha = 0.77$) 3. Depression and hopelessness ($\alpha = 0.86$) 4. Memory self-efficacy ($\alpha = 0.81$)	49%	1,2,5,7,8,17,26,29,32,36,39,40 (factor loading<0.4)
Ksondzyk (2020)	Ukrainian 26 items	252 Ukrainian tertiary music students and professional musicians from Lviv, Ivano, Frankivsk, Kyiv, Ternopil, Kharkiv, who worked in state music education institutions, music academies and philharmonic societies 59% female, mean age = 35.32, SD = 13.3, range 18–72 years	EFA ($\alpha = 0.87$) CFA	1. Proximal performance concerns ($\alpha = 0.90$) 2. Psychological vulnerability ($\alpha = 0.83$) 3. Early relationship context ($\alpha = 0.66$). 1. Proximal somatic anxiety ($\alpha = 0.86$) 2. Worry/dread (negative cognitions) ($\alpha = 0.82$) 3. Depression/hopelessness ($\alpha = 0.74$), 4. Anxious apprehension ($\alpha = 0.84$) 5. Parental empathy ($\alpha = 0.65$), 6. Generational transmission of anxiety ($\alpha = 0.66$)	62.8% for 7 factor model, 45% for 3 factor model	2,3,8,26 (factor loading<0.416)
Oh et al. (2020)	Korean	69 art high school students	EFA	1. Worry/dread and negative cognitions 2. Proximal somatic anxiety and worry about performance 3. Depression/hopelessness 4. Parental empathy–memory controllability 5. Generational transmission of anxiety 6. Trust 7. Rumination	61%	
Chang-Arana et al. (2018)	Spanish Peru	455 Peruvian tertiary music students (25% female; mean age = 21.19 years, SD = 3.13, range = 18–40 years) and 368 Australian professional orchestral musicians (51% female; mean age = 42.07 years, SD = 10.21, range = 18–68 years)	First order EFA High order EFA (HOEFA) with Min Rank Factor Analysis (MRFA)	1. Proximal performance concerns 20 items, ($\alpha = 0.91$), 2. Psychological vulnerabilities seven items, ($\alpha = 0.80$) 3. Confidence in memory two items, ($\alpha = 0.82$) 4. Early parental relationship context three items, ($\alpha = 0.71$). 1. Negative affectivity in relation to music performance ($\alpha = 0.92$) 2. Music performance anxiety ($\alpha = 0.91$) 3. Depression ($\alpha = 0.81$)	59% 59%	8,9,22,23,25, 33, 35, 37,40 (factor loading<0.3)

(Continued)

TABLE 1 (Continued)

Authors	Language	Sample	Reliability	Factors	Variance explained	Items excluded (criterion for exclusion)
Barbar et al. (2015)	Portuguese Brazilian	230 graduate or undergraduate level amateur musicians (58% female; mean age 39.17 years – SD = 16.48).	EFA	1. Worries and insecurity ($\alpha = 0.82$) 2. Depression and hopelessness ($\alpha = 0.77$) 3. Early parental relationships ($\alpha = 0.57$).	62%	
Zarza-Alzugaray et al. (2015)	Spanish (26 items)	Tertiary music students in conservatories in Spain $n = 215$ (EFA) $n = 275$ (CFA)	EFA CFA	Seven factors – full scale $\alpha = 0.8$ Three factors corresponding to Barlow (2000) and Kenny (2009). 1. Early life context ($\alpha = 0.57$) 2. Psychological vulnerability ($\alpha = 0.79$) 3. Specific cognitions re performance context ($\alpha = 0.87$)	58%	2,8,19 (factor loading<0.3) 2,5,8,26 (factor loading<0.3)

comprising three subtypes to account for qualitative differences in clinical presentation, severity, and co-morbidities. The three subtypes are: (i) MPA as a focal anxiety, where there is no generalized or social anxiety, depression or panic and the anxiety is specifically focused on an objectively highly stressful performance such as an audition or solo recital; (ii) MPA comorbid with other anxiety disorders, in particular social anxiety disorder; and (iii) MPA with panic and depression (see Kenny, 2011, for a detailed discussion). The items in the K-MPAI are specifically constructed to assess these dimensions.

I have introduced a number of new concepts or alternate ways of understanding existing concepts (e.g., anxiety) for consideration in our conceptualization of MPA. These include taking a life course, intra-and interpersonal developmental perspective rather than a symptomatic approach to MPA presentations (although these are important for both diagnostic and therapeutic purposes), to identify attachment quality and defensive mechanisms used to shore up self-concept and self-esteem in case formulations, and to consider comorbidities in presentation, including, in particular, other anxiety disorders, depression, and somatization, and fragile personality structure (poor self-concept, low self-esteem, low self-efficacy, poor emotion regulation), as well as reconsidering the role and meaning of anxiety in music performance anxiety specifically. The challenge has been to evaluate these complex constructs heuristically *via* a questionnaire while understanding that there is no substitute for a detailed clinical interview, assessment, and formulation. I will now briefly review some key concepts relevant to MPA.

4. Ways of understanding anxiety

Anxiety can be understood from several perspectives, including psycho-neurobiological, physiological, and clinical, including psychodynamic and attachment-based psychotherapy. A brief description of each follows.

4.1. Psycho-neurobiological perspective

Anxiety is understood as an adaptive alarm during which a freeze response may occur in some threatening situations. Specifically, freezing—or tonic immobility—may overwhelm other competing action tendencies in situations where fleeing or aggressive (fight) responses are likely to be ineffective. Evolution has endowed all humans with a continuum of innate, hard-wired, automatically activated defense behaviors, called the defense cascade. Threat activates the defense cascade; flight or fight are active defense responses for dealing with threat; freezing over-rides the flight-or-fight response; tonic immobility and collapsed immobility (i.e., fainting) are responses of last resort to inescapable threat, when fear becomes overwhelming and active defense responses have failed. During this phase in the cascade, muscle tone is lost, and consciousness is compromised secondary to bradycardia-induced cerebral hypoxia. Quiescent immobility may occur after the threat has passed; it promotes rest and healing. Each of these defense reactions has a distinctive neural signature that is mediated by a common neural pathway: activation and inhibition of functional components in the amygdala, hypothalamus, periaqueductal gray, and sympathetic and vagal nuclei. The responses that make up the defense cascade are primitive emotional states—coordinated patterns of a motor-autonomic-sensory response—that may be automatically activated in the context of danger. The activation of defense responses along this cascade are generally thought to be beyond conscious control and affect muscle (i.e., somatomotor activation), viscera (visceromotor activation) and pain perception and processing in which the triggering of non-opioid analgesia blocks ascending pain signals. Freezing in humans is usually a transient state that occurs at the beginning of the threat experience. It involves heightened attention, enhanced vigilance to threat cues, and an activated, tense body poised for action. It is usually accompanied by a drop in motor activity and a decrease in heart rate. Panic and the flight impulse are closely associated with the freeze response. Porges's polyvagal theory (Porges, 2001, 2007, 2011) added a third dimension to this conceptualization–the communication and social engagement system that has relevance to our understanding of all anxiety disorders.

4.2. Physiological perspective

It is important to distinguish physiological arousal (alertness, activation) which refers to the intensity of behavior that varies on a continuum from deep sleep to intense excitement or fear from somatic anxiety. Arousal is initially non-directional and may be experienced as excitement or fear. Changes in arousal levels are reflected in changes in autonomic reactivity and are experienced as elevated heart rate, blood pressure, respiration, sweating, muscle tension, indigestion,

urinary frequency, increased or decreased body temperature. I have covered the subject of somatic anxiety and its management in Kenny (2011) and the interested reader is referred to that source for a more detailed discussion. I have also dealt with cognitive anxiety in the same reference, which occurs in the presence of psychological stressors, and which involves the hypothalamic–pituitary–adrenal axis. Musicians may report somatic or cognitive anxiety (anxious apprehension, fear, dread, worry, rumination, catastrophizing) alone or in concert, with each form varying along its own severity dimension. Most early studies of MPA focused on somatic anxiety experienced by musicians in situations of evaluative threat. We now know that cognitive anxiety is an additional component to MPA that is at least partially independent of somatic anxiety, i.e., one can experience high somatic anxiety and low cognitive anxiety, or low somatic anxiety and high cognitive anxiety.

4.3. Clinical perspectives

4.3.1. Psychodynamic perspective

Freud (1926) conceptualized anxiety as both an affective signal for danger (similar to the psycho-neurobiological model) and the motivation for psychologically defending against that (perceived) danger. When an individual senses a danger situation, she is motivated to defend against the anxiety. Freud distinguished between traumatic or primary anxiety, i.e., a state of psychological helplessness in the face of overwhelmingly painful affect, such as fear of abandonment or attack, and signal or secondary anxiety, which is a form of anticipatory anxiety that alerts us to the danger of re-experiencing the original traumatic state by repeating it in a weakened form such that measures to protect against re-traumatization are enacted. In the case of musicians with performance anxiety, the danger signal relates both to early danger experiences, such as pressure and/or failure to perform well under conditions of evaluative threat, which are internalized, and current experiences of performance and performance anxiety, which are interpersonal and occur between the performer and the audience, but which are understood and interpreted within the framework of the earlier, internalized anxiety experiences. By simultaneously attending to both sets of danger experiences – the internalized past and the interpersonal present, sense can be made of the performer's current experiences of endangerment in the performance setting.

4.3.2. Attachment informed formulation

In an attachment-based formulation, anxiety acts as a defense against emotional pain erupting from re-triggered early attachment trauma in the present. The sequence is as follows: The rupture in the attachment relationship causes emotional pain in the child and a retaliatory rage toward the parent for causing the child pain. However, because the child also loves her parent, she feels guilt about experiencing rage toward someone she loves. The rage, guilt about feeling rage, grief and craving for attachment and positive feelings are all repressed into symptoms and submerged under behaviors that enable the child to continue a relationship with her parent. When the child is required to meet the needs of its primary caregivers at the expense of her own psychological development, spontaneous experience and metacognitive processes of self-reflection and the emerging sense of self is usurped and marginalized. This process eventually becomes a characteristic defensive system described as pathological accommodation (Brandchaft, 2007) or fragile character structure (Davanloo, 1995). Whenever the child is in a situation that has the potential to rupture the attachment bond, the repressed rage, guilt about the rage, grief and pain from the initial attachment rupture is re-triggered. Anxiety is experienced to block the feelings from entering conscious awareness. The defensive system is automatically activated to keep the feelings repressed and to avoid or alter the emotionally triggering situation. Over time, this pattern is automatically triggered in any situation that has the potential to elicit the repressed feelings about the original attachment rupture.

Consider the case study presented below.

> A young violist in her final year of music studies at a prestigious music conservatorium presented with severe music performance anxiety that manifested in hand tremor and bow shake which in turn affected her control of her instrument, rhythmic precision, and tonal quality. She was soon to audition for places in state and national orchestras and feared that her mental state would preclude success. I recommended that she commence beta blockers immediately for symptom relief of severe manifestations of somatic anxiety while we worked psychodynamically on the underlying causes of her MPA. She commented in one session that when she really wanted something, she believed in her mind that she should have it, and when it didn't happen, she was devastated. This included "having" a perfect performance. This comment had the flavour of "psychic equivalence" – that inner wishes and outer reality should match. This comment felt pivotal to me, suggesting that (part of) her emotional development had been arrested at a very young age. The other significant feature was her fear of appearing either arrogant (paternal introject) or too needy (maternal introject) – uncomfortable opposites inhabiting the same body – rendering her an observer rather than a participant in all her performances and social interactions. She was avoidantly attached to her father, a poorly attuned, authoritarian figure, and experienced a preoccupied attachment with her mother, who modelled fearfulness of and submissiveness towards her husband which our young violist emulated with all authority figures including her therapist, in front of whom she could barely complete a sentence for the first several weeks of psychotherapy.

In Kenny (2011), I report in detail on a number of musicians with whom I have worked psychotherapeutically over the years. I have concluded that the underlying psychopathology of severe MPA is an attachment rupture in early life that is unresponsive to cognitive behavioral therapies. I invite you to revisit these cases as they are most instructive regarding the complexity and multi-dimensionality of music performance anxiety (MPA). Since then, I have published a number of studies on the central role that attachment quality plays in the etiology of MPA in its most severe form (see, for example, Kenny and Holmes, 2015, 2018; Kenny et al., 2016; Kenny, 2016b). These papers investigate attachment themes in the life history narratives of professional musicians and their relationship with MPA. The underpinning hypothesis is that the performance setting re-triggers unprocessed feelings related to early attachment experiences, especially when traumatic, and that defensive manoeuvres against their re-emergence into consciousness are activated. Idiographic research highlights early relational trauma as a relevant etiological factor in the MPA-symptomatic of anxious musicians.

I have therefore argued for an attachment-informed life-course model rather than a purely symptomatic approach to understanding and treating severe MPA and other intra-personal psychodynamics of performing musicians. Empirical support for this hypothesis is now emerging. In conducting attachment-informed intake assessments, it is important to note the following elements in the history: Presence of psychological vulnerability, behavioral inhibition, and/or sensitizing experiences (Kenny and Osborne, 2006), parental mis/attunement, presence or absence of an internal secure base, the quality of current musical experience, and any re-triggering of attachment trauma in current experiences with music performance. These elements of attachment align with Barlow's three factors–biological vulnerability (negative affect, behavioral inhibition), psychological vulnerability (lack of an internal secure base, experienced as a sense of unpredictability and uncontrollability, and that one does not have the necessary coping resources), and sensitizing past, current, or triggering experiences, all of which I attempted to capture in the K-MPAI.

A recent study (Wiedemann et al., 2020) exploring the relationship between parenting style, adult attachment type, and MPA using a German translation of the K-MPAI showed significant relationships between overcontrolling and abusive parenting style in both parents and indifference in the mother and higher scores on the K-MPAI. Further, significant main effects of adult attachment on MPA were found for the four attachment prototypes [secure, dismissing (also known as avoidant), preoccupied, anxious] with dismissing (avoidant) attachment styles scoring lowest on MPA and anxious and preoccupied scoring highest on MPA. These findings are consistent with the attachment literature regarding how people respond to situations and relationships in adulthood. Secure and dismissing attachment are associated with higher self-concept than anxious and preoccupied attachment, which in turn is associated with the degree of comorbid generalized and specific anxieties (Shaver et al., 2009).

4.4. Comorbidity of MPA with other anxiety disorders

There has been ongoing controversy regarding the question as to whether MPA is a form of social anxiety disorder (SAD) (social phobia) (Barbar et al., 2014b), whether it is frequently comorbid with SAD (Kenny, 2011), or whether SAD is independent of MPA (Wiedemann et al., 2022). This is an important question for theoretical, diagnostic, and therapeutic reasons and deserves serious attention. DSM IV (1994) and DSM IV Tr (2000) presented MPA as a subtype of SAD, but others have questioned this (e.g., Kenny, 2011; Kenny, 2016a) arguing that MPA and SAD differ in significant ways and that SAD may be comorbid with MPA rather than MPA being a subtype of SAD. A study of Australian professional orchestral musicians found that one third of this population met criteria for SAD, with more females demonstrating greater comorbidity, as is the case in the general population. The State–Trait Anxiety Inventory (STAI-T), a measure of more generalized anxiety, the Social Phobia Inventory (SPIN), the Anxiety and Depression Detector (ADD), and younger age were all independent predictors of MPA severity (Kenny et al., 2012). A study of 82 music students, using a German translation of the K-MPAI and the disorder-specific anxiety measures of the DSM 5 (APA, 2013)–including agoraphobia, generalized anxiety disorder (GAD), panic disorder (PD), separation anxiety disorder, specific phobia, SAD, and illness anxiety disorder–found GAD scores to be the best predictor of MPA (Wiedemann et al., 2022). This is not surprising given the high correlations reported between STAI-T and MPA, although the DSM measure is diagnostic of GAD and therefore adds to our clinical understanding of the severity of comorbid anxiety conditions. Of interest in this German study is the finding that those student musicians with pathological anxiety profiles consistently reported clinically significant levels of MPA, while those whose anxiety scores were within the normal range had variable MPA scores, falling within both higher and lower ranges of MPA severity. I would hypothesize that those with normal anxiety, but high MPA met my criteria for focal MPA. Such individuals may simply have a biologically more reactive autonomic nervous system rather than any identified psychopathology. It is this group who may benefit most from beta blockers if their anxiety is mostly somatic (as opposed to cognitive) in nature.

However, before we reach any precipitous conclusions on the matter, consider the concept of the "illusion of mental health based on denial or self-deception" proposed by Cousineau and Shedler (2006), pp. 427-432 who found strong associations between the defensive denial of distress and/or mental health issues and higher physiological reactivity. It is important to complement nomothetic with idiopathic, qualitative (Kenny and Holmes, 2018), narrative, and single case design (Kenny and Holmes, 2015) studies to elucidate the puzzling findings from population studies. Individual level analysis highlights that variability is the rule not the exception. For example, counter-intuitively, a study of skilled musical performance in tertiary level flute players showed individualized patterns of concordance-non-concordance between self-reported anxiety on the STAI-T and K-MPAI, heart rate, and EMG measures (Kenny et al., 2013).

There are several other factors that play a role in the genesis and severity of MPA that require further attention. These include depression, low self-esteem, and somatization.

5. Depression

Depression has only recently been considered as a comorbidity in the more severe forms of MPA although it is the case that in all forms of anxiety, both general and MPA, anxiety tends to be more severe in the presence of comorbid depression (Kenny, 2011; Kenny et al., 2012; Kenny and Ackermann, 2015). Indeed, depression also has a complex interaction with reports of performance-related musculoskeletal disorders in orchestral musicians, a topic to which I will return in the section on somatization.

Depression can be both a cause and outcome of unresolved MPA, particularly in the presence of low self-esteem and a fragile personality structure. For example, demonstrating cause, Barbar et al. (2014c) investigated professional Brazilian musicians, reporting that musicians with MPA were 3.87 times more likely to develop depression compared with musicians with low or no MPA. Rates of depression within the music sample were high–24% for the professional and 17% for amateur musicians. Demonstrating outcome, Sickert et al. (2022), using a sample of 295 German musicians of varying professional and educational standards, found that three subscales of the K-MPAI–proximal somatic anxiety and worry about performance (factor 1), worry/dread/negative

cognitions/ruminations focused on self/other scrutiny (factor 2), and anxious apprehension (factor 3)–predicted depression using the *Beck Depression Inventory*; low self-esteem using *Rosenberg Self-Esteem Scale* also predicted K-MPAI factor scores, which in turn significantly predicted depression. Music students had significantly lower self-esteem compared with employed professional musicians. This finding could represent a self-selection bias among the professional musicians, i.e., only the most talented and confident progressed to professional status in their music careers. Further, they were older and hence more emotionally mature, with greater coping resources and perhaps less maladaptive perfectionism that is often observed in tertiary music students. Nonetheless, this sample of musicians reported more depression at higher levels compared with the general German population. There have been several calls in the literature to examine more closely the impacts of situational factors (Papageorgi, 2022) and musical pedagogy methods in tertiary music institutions globally (Jimenez, 2016; Carrasco, 2019; Clearman, 2020) that may be contributing to poor mental health, loss of confidence, and high MPA in music students.

6. Low self-esteem, "false self," and pathological accommodation

> A young woman studying a combined law and music performance degree presented with concerns about what she described as a debilitating form of stage anxiety. She said that it had been prominent as far back as she could remember and that it had prevented her from truly enjoying the one thing she considered a means of refuge in her life. Recently, this anxiety had begun to affect the outlook she had in all areas in her life … "with each performance breakdown, I feel like I am just a useless piece of carbon with no purpose." This young woman hated her law degree but felt compelled to continue due to parental pressure and expectation. However, she wanted to be a musician. We subsequently discussed how she took in the commands and expectations from outside, leaving no space within to know her own mind. As the elder child of a working mother and invalid father, she became prematurely adult and presented with a "false self" façade. This entailed a pseudo-sophisticated, excessively polite, and deferential manner. She was always trying to be "good", to please her parents and meet their expectations, to "make something" of herself, so that she would not "be nothing like her father". The degree of pathological accommodation to externally imposed expectations left her wondering whose life she was living. She needed to separate and individuate from her enmeshed family, and to "discover her own mind." Several weeks into therapy, she had a revelatory moment. "Wow! A blank slate … I am not liking it … [she burst into tears] … if I am a blank slate or canvas, I am the painter and the canvas; I am standing here with all the paints not knowing which one to choose."

I have discussed in my book and elsewhere in case reports about the organization and perception of self that underpins all our reactions to life in general and to stressful situations in particular. I refer the interested reader to these sources for a detailed discussion. Suffice to say here that anxiety, attachment, propensity for negative affect and depression, somatization which is a defense against emotional pain, and self-concept/self-efficacy are intricately interwoven. In our study of orchestral musicians, the Core Self Efficacy measure (CSE) (Judge et al., 2003) was negatively correlated with all other measures of general anxiety, MPA, and depression (Kenny et al., 2012). For example, the correlation between K-MPAI and CSE was-0.771, i.e., the lower CSE, the higher MPA. Core self-efficacy encompasses the constructs of self-esteem, locus of control, generalized self-efficacy, and neuroticism (negative affect) and attempts to encapsulate an individual's sense of "being-in-the-world" in terms of belief in one's capacity to manage one's life and its challenges, while maintaining optimism, and a sense of purpose and meaning, even in the face of (perceived) failure and the exigencies of life. These internalized feelings about oneself develop in the primary relationship with the first caregivers (i.e., attachment quality). Lack of attunement, neglect, criticism, overcontrol, overprotectiveness, high expectation with low support, among other dysfunctions in this relationship leaves the young person with a depleted sense of self, fearful of life and doubtful of her capacity. Self-efficacy is also content specific and partly determined by one's skills and abilities–for example, one can have high self-efficacy for music performance, but low self-efficacy for mathematics. I worked with one young violinist who struggled with severe MPA when playing technically challenging studies and exercises for her teacher. She told me that she was an "esthetic musician" with great capacity for interpretation and musical nuance (high self-efficacy) and she hoped this would make up for her technical deficits (rationalization and minimization of the need for technical competence/mastery). Denial of the importance of central elements to the achievement of an outcome is not an adaptive response to one's deficits and will ultimately generate significant MPA in young musicians. There has been increasing interest in self-efficacy research in music performance which promises to be a fruitful direction for future research (Egilmez, 2015; Demet, 2017; Dobos and Piko, 2017; Orejudo et al., 2017; González et al., 2018; Zarza-Alzugaray et al., 2020).

7. Somatization

> An operatic tenor presented to therapy with globus pharyngeus, described as a relatively common persistent or intermittent non-painful sensation of a lump or foreign body in the throat that can make swallowing difficult (Lee and Kim, 2012). Unfortunately, it has uncertain etiology and tends to be treatment resistant. He had received a thorough workup from an otolaryngologist and no physical findings were noted. He had received a trial of proton pump inhibitors assuming possible underlying gastroesophageal reflux with no improvement. He had attended speech and language therapy and was prescribed anti-depressants to no avail. After this diagnostic and clinical marathon, he was referred to me. In the course of history-taking, I asked him whether he was partnered. He replied, "Yes [bringing his hand to his throat] and she [my voice] is a bitch," whereupon he began to weep.

An association has been established in general medical populations between frequency of reports of acute and chronic pain and severity of

pain and comorbid psychological disorders, especially anxiety and depression. There have been few studies on musicians who, by nature of their profession, experience high levels of performance-related musculoskeletal pain disorder (PRMD). Kenny and Ackermann (2015) examined self-reported frequency and severity of PRMD, depression, social phobia, and MPA using K-MPAI in a cross-sectional survey of 377 professional Australian orchestral musicians. Most (84%) musicians had experienced performance-impairing pain; 50% reported current pain at the time of the study. Females reported more performance-impairing pain and more current pain than males. Cluster analysis indicated a complex relationship between depression and PRMD severity. Three clusters showed the expected linear association (i.e., more depression, more pain), but not causality, which may be bidirectional. Musicians in the fourth cluster denied depression but reported the most severe pain, suggesting a group who somatize their psychological distress in the way demonstrated by our operatic tenor. There was also a strong relationship between PRMD and MPA severity, with higher scores on K-MPAI strongly associated with greater PRMD severity. One possible mechanism to account for these findings is the excess muscle tension experienced by anxious people. Tension and anxiety can be expressed in the striated muscles leading to muscle pain and spasms, tremors, or loss of fine motor control or in the smooth muscles, where anxiety is somatized into the gut resulting in more serious somatic symptoms such as nausea, reflux, cramping, and the urge to urinate and/or defecate.

Of course, PRMDs are not attributable solely to psychological factors. Biomechanical factors such as type and weight of instrument, hours practiced, pattern of practice, carrying one's instrument, and orchestral musician seating all create occupational hazards in the musician's workplace, in addition to difficulties with conductors, management, and policies and procedures. Biomechanical considerations apply less to singers who carry their voices within their bodies. However, as the vignette above shows, singers have a very complex relationship with their voices. Contextual factors such as music genre specialization (Papageorgi et al., 2011) and quality and type of pedagogy (Jeong and Ryan, 2022) could also contribute to pain, depression, and MPA in musicians and these factors must be assessed simultaneously with any proposed psychological components thought to contribute to pain reports.

8. Future directions

Current research has pointed to the possible redundancy of some items in the 40-item version of the K-MPAI. Zarza-Alzugaray et al. (2015) have proposed that "… studies be conducted on the 40-item version of the inventory to further explore interactions between the factors found in the 26-item version, particularly with the aim of assessing specific vulnerability factors proposed by the model which are specified in the 40-item version of the inventory." I concur with this suggestion. "Early parental/relational context" while emerging as a factor and showing adequate internal consistency in most studies of the factorial structure of the K-MPAI appears more susceptible to cultural influences than the other factors. This may be due to different parenting styles cross-culturally and other environmental variations that may warrant further investigation and more precise specification. Strongly related to this factor is further examination of the role that self-concept/self-esteem, "false self," and pathological accommodation may play in the development and severity of MPA. The outcome of all these developmental experiences is self-efficacy, but this should not be treated as a discrete variable, rather as an emergent, malleable part of the self that can be modified if identified early in development.

The field of music performance has lagged behind developments in sport psychology in this regard, specifically in the preparation of young people to manage the stress of public performance that is closely scrutinized and evaluated in competitive environments, often before the young person is mature enough to negotiate the pitfalls of premature exposure to such stressors. In assessing MPA, more attention needs to be focused on matters related to pedagogy (e.g., pathological accommodation can occur in the relationship between teacher and student, as well as parent and child, given the importance that teachers assume in preparing young people for musical careers). Practice routines, consolidating technical mastery of the instrument, performance preparation including the suitability of repertoire for the age and development of the young musician, the avoidance of thrusting young musicians into stressful performance situations for which they may not be adequately prepared, ensuring that the child engages in childhood activities like play, sport, leisure, and other intellectual interests apart from music, are all critical to the development of core self-efficacy that is preventive of psychological disorders, including debilitating MPA. The ideal in child development is prevention. In music, we know that sensitizing experiences (i.e., trauma in music performance) can occur early in the young musician's performance experience and cast a menacing shadow over all subsequent musical endeavors (Osborne and Kenny, 2008). How such experiences can be minimized or avoided is a worthy question that future researchers could helpfully address.

In addition to the K-MPAI, I have developed three MPA rating scales that may warrant further attention. These are (i) *Performance anxiety in different performance settings rating scale* in which musicians rate the degree of anxiety experienced in nine performance situations, including two non-music performance settings (i.e., oral presentation and a written exam); (ii) A 22-item *Perceived causes of music performance anxiety checklist* derived from therapeutic interviews with anxious musicians; and (iii) *Self-management of music performance anxiety rating scale* in which musicians select from a list of 18 strategies those that they used to manage their MPA and to rank each strategy for perceived effectiveness (Kenny, 2011; Kenny et al., 2012). I have found the use of these checklists both illuminating and therapeutically useful.

Another area that warrants further attention is the role that occupational stress and workplace/music study climate, occupational role concerns, and occupational personal strain play in generating or maintaining unacceptably high levels of MPA, together with a study of the resilience and personal resources and coping strategies [see (iii) above] that mitigate these stressors. For example, there are few occupations that require workers to audition every year to maintain their position as occurs in some performing arts companies. In one early study exploring these factors in operatic chorus artists, results showed that higher scores on personal resources were associated with the higher scores on trait anxiety, suggesting that these resources were used adaptively to manage anxiety. High trait anxiety was also associated with higher personal strain in the work environment (Kenny et al., 2004). Differently configured physical working environments may also affect musician well-being and MPA levels experienced during performance (see, e.g., Kenny et al., 2016).

Outcomes of investigations in this area may have significant implications for workplace management practices that could ease the stress of professional musicians (Ackermann et al., 2014).

Performance quality, by virtue of the inherent difficulties in measuring it, is too infrequently included in studies of MPA impacts and outcomes of therapeutic interventions. It is a critical variable for both the researcher and the performer and deserves more attention in the MPA literature (Kenny et al., 2013).

Finally, just as medical practice is becoming increasingly personalized with the development of "precision medicine," so too should our discipline of psychology become more idiographic (i.e., individualized/personalized) in its research interests (Kenny, 2011). Psychology is now essentially the study of groups and populations, in which distilled results are reported in randomized controlled trials, regression, factor, path, and meta-analyzes. Allport (1955) made the same observation when psychology was still in its formative years. He urged us to take the road less travelled, noting that psychologists should continue to struggle with the "dilemma of uniqueness … [that we need to understand that] each person is an idiom unto himself, an apparent violation of the syntax of the species". We therefore need to be mindful of the unique quality of anxiety in each individual musician in order to advance our field of study in music performance anxiety.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

Author DK is Principal, DK Consulting.

Publisher's note

Supplementary material

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References

Ackermann, B. J., Kenny, D. T., O'Brien, I., and Driscoll, T. R. (2014). Sound practice–improving occupational health and safety for professional orchestral musicians in Australia. *Front. Psychol.* 5:973. doi: 10.3389/fpsyg.2014.00973

Allport, G. W. (1955). *Becoming: Basic Considerations for a Psychology of Personality*. New Haven: Yale University Press.

Antonini Philippe, R., Cruder, C., Biasutti, M., and Crettaz von Roten, F. (2022a). The Kenny music performance anxiety inventory-revised (K-MPAI-R): validation of the Italian version. *Psychol. Music* 50, 389–402. doi: 10.1177/030573562211014

Antonini Philippe, R., Kosirnik, C., Klumb, P. L., Guyon, A., Gomez, P., and Crettaz von Roten, F. (2022b). The Kenny music performance anxiety inventory–revised (K-MPAI-R): validation of the French version. *Psychol. Music* 50, 389–402. doi: 10.1177/03057356211002642

APA. (1994). *Diagnostic and Statistical Manual (DSM IV)*. Washington, DC: American Psychiatric Association.

APA. (2000). *Diagnostic and Statistical Manual (DSM IV-Tr)*. Washington, DC: American Psychiatric Association.

APA. (2013). *Diagnostic and Statistical Manual (DSM 5)*. Washington, DC: American Psychiatric Association.

Barbar, A. E., Crippa, J. A., and Osório, F. L. (2014a). Kenny music performance anxiety inventory (KMPAI): transcultural adaptation for Brazil and study of internal consistency. *J. Depress. Anxiety* 3:167. doi: 10.4172/2167-1044.1000167

Barbar, A. E., Crippa, J. A., and Osório, F. L. (2014b). Parameters for screening music performance anxiety. *Rev. Bras. Psiquiatr.* 36, 245–247. doi: 10.1590/1516-4446-2013-1335

Barbar, A. E., Crippa, J. A., and Osório, F. L. (2014c). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 152, 381–386.

Barbar, A. E., Souza, J. A., and Osório, F. L. (2015). Exploratory factor analysis of Kenny music performance anxiety inventory (K-MPAI) in a Brazilian musician sample. *Arch. Clin. Psychiatry (São Paulo)* 42, 113–116. doi: 10.1590/0101-60830000000060

Barlow, D. H. (2000). Unravelling the mysteries of anxiety and its disorders from the perspective of emotion theory. *Am. Psychol.* 55, 1247–1263. doi: 10.1037/0003-066X.55.11.1247

Barlow, D. H.. (2004). *Anxiety and its Disorders: The Nature and Treatment of Anxiety and Panic*. New York: Guilford Press.

Bober, C. C.. (2019). *The Experience of Music Performance Anxiety for Popular Musicians: A Transcendental-Phenomenological Investigation*. Farmington Hills, MI: Michigan School of Psychology

Brandchaft, B. (2007). Systems of pathological accommodation and change in analysis. *Psychoanal. Psychol.* 24, 667–687. doi: 10.1037/0736-9735.24.4.667

Brodsky, W. (1996). Music performance anxiety reconceptualised: a critique of current research practice and findings. *Med. Probl. Perform. Art.* 11, 88–98.

Carrasco, G. E.. (2019). *Perceived Extrinsic Factors Affecting Music Performance Anxiety in Undergraduate Musicians*. (Hons), Southeasetern University, Lakeland. Available at: https://firescholars.seu.edu/cgi/viewcontent.cgi?article=1123&context=honors

Casanova, O., Zarza, F. J., and Orejudo, S. (2018). Differences in performance anxiety levels among advanced conservatory students in Spain, according to type of instrument and academic year of enrolment. *Music. Educ. Res.* 20, 377–389. doi: 10.1080/14613808.2018.1433145

Chang-Arana, Á. M. (2015). *Adaptation and Psychometric Properties of the Kenny-music Performance Anxiety Inventory (K-MPAI) (Unpublished Bachelor Thesis)*. Peru: University of Lima.

Chang-Arana, Á. M. (2017). *Spanish Version of the Kenny-Music Performance Anxiety Inventory (K-MPAI): Factorial Structure and First Statistical Analyses of a Peruvian Sample*. London, England: Paper Presented at the 10th International Conference of Students of Systematic Musicology.

Chang-Arana, Á. M., Kenny, D. T., and Burga-León, A. A. (2018). Validation of the Kenny music performance anxiety inventory (K-MPAI): a cross-cultural confirmation of its factorial structure. *Psychol. Music* 46, 551–567. doi: 10.1177/0305735617717618

Çiçek, V., and Güdek, B. (2020). Adaptation of the music performance anxiety inventory to Turkish: a validity and reliability study. *J. Acad. Soc. Sci. Stud.* 81, 153–163. doi: 10.29228/JASSS.45980

Clearman, J. A. (2020). "Experiences in music performance anxiety: exploration of pedagogical instruction among professional musicians" in *Perspectives in Performing arts Medicine Practice*. eds. S. H. Lee, M. L. Morris and S. V. Nicosia (Berlin: Springer), 241–255.

Connor, K. M., Davidson, J. R., Churchill, L. E., Sherwood, A., Foa, E., and Weisler, R. H. (2000). Psychometric properties of the social phobia inventory (SPIN). New self-rating scale. *Br. J. Psychiatry* 176, 379–386. doi: 10.1192/bjp.176.4.379

Cousineau, T. M., and Shedler, J. (2006). Predicting physical health: implicit mental health measures versus self-report scales. *J. Nerv. Ment. Dis.* 194, 427–432. doi: 10.1097/01.nmd.0000221373.74045.51

Davanloo, H. (1995). Intensive short-term dynamic psychotherapy: Spectrum of psychoneurotic disorders. *Int. J. Short-Term Psychother.* 10, 121–155.

Demet, G. (2017). The relations among musical instrument performance self-efficacy, self-esteem and music performance anxiety in pre-service music teachers. *Educ. Res. Rev.* 12, 611–616. doi: 10.5897/ERR2017.3251

Dias, P., Veríssimo, L., Figueiredo, N., Oliveira-Silva, P., Serra, S., and Coimbra, D. (2022). Kenny music performance anxiety inventory: contribution for the Portuguese validation. *Behav. Sci.* 12:18. doi: 10.3390/bs12020018

Dobos, B., and Piko, B. (2017). Risk and protective factors of music performance anxiety: the role of stress, self-esteem and self-efficacy. *Eur. Health Psychol*, 9:1046.

Dobos, B., Piko, B. F., and Kenny, D. T. (2019). Music performance anxiety and its relationship with social phobia and dimensions of perfectionism. *Res. Stud. Music Educ.* 41, 310–326. doi: 10.1177/1321103X18804295

Egilmez, H. O. (2015). Pre-service music teachers' piano performance self-efficacy belief inversely related to musical performance anxiety levels. *Educ. Res. Rev.* 10, 2558–2567. doi: 10.5897/ERR2015.2439

Fakhr, I. (2020). The correlation between music performance anxiety and self-esteem in western classical music performance students. *J. Field Art* 1:11.

Faur, A. L., Vaida, S., and Opre, A. (2021). Kenny music performance anxiety inventory: exploratory factor analysis of the Romanian version. *Psychol. Music* 49, 777–788. doi: 10.1177/0305735619896412

Figueiredo, N. M. (2020). *Kenny Music Performance Anxiety Inventory: Contributos Para a Validação Portuguesa*. Master Dissertations.

Freud, S. (1926). *Inhibitions, Symptoms and Anxiety*. *20*, London: Hogarth Press.

González, A., Blanco-Piñeiro, P., and Díaz-Pereira, M. P. (2018). Music performance anxiety: exploring structural relations with self-efficacy, boost, and self-rated performance. *Psychol. Music* 46, 831–847. doi: 10.1177/0305735617727822

Haninditya, F. Y. (2021). Hubungan antara kecemasan performa musikal dan efikasi diri pada pemusik. *Acta Psychol.* 3, 156–162.

Jelen, B. (2021). The relationships between music performance anxiety and the mindfulness levels of music teacher candidates. *Int. Educ. Stud.* 14, 116–126. doi: 10.5539/ies.v14n10p116

Jeong, S. S. Y., and Ryan, C. (2022). A critical review of child perfectionism as it relates to music pedagogy. *Psychol. Music* 50, 1312–1327. doi: 10.1177/03057356211042080

Jimenez, F. M. (2016). *Music Performance Anxiety and Interventions in Conservatory and Liberal Arts Institution Music Students*. Claremont College, Available at: https://scholarship.claremont.edu/cgi/viewcontent.cgi?article=1777&context=scripps_theses

Judge, T. A., Erez, A., Bono, J. E., and Thoresen, C. J. (2003). The core self-evaluations scale: development of a measure. *Pers. Psychol.* 56, 303–331. doi: 10.1111/j.1744-6570.2003.tb00152.x

Juncos, D. G., and De Paivae Pona, E. (2018). Acceptance and commitment therapy as a clinical anxiety treatment and performance enhancement program for musicians: towards an evidence-based practice model within performance psychology. *Music Sci.* 1:74880. doi: 10.1177/2059204317748807

Juncos, D. G., Heinrichs, G. A., Towle, P., Duffy, K., Grand, S. M., Morgan, M. C., et al. (2017). Acceptance and commitment therapy for the treatment of music performance anxiety: a pilot study with student vocalists. *Front. Psychol.* 8:986. doi: 10.3389/fpsyg.2017.00986

Kantor-Martynuska, J., and Kenny, D. T. (2018). Psychometric properties of the Kenny-music performance anxiety inventory modified for general performance anxiety. *Pol. Psychol. Bull.* 49:500. doi: 10.24425/119500

Kbodadadeh, R., Momeni, K., Jadidi, H., and Akbari, M. (2022). Psychometric properties of music performance anxiety inventory. *Journal of Positive School Psychology* 6, 322–332.

Kenny, D. T. (2009). *The Factor Structure of the Revised Kenny Music Performance Anxiety Inventory*. In: International Symposium on Performance Science. Utrecht: Association Européenne des Conservatoires, pp. 37–41.

Kenny, D. T. (2011). *The Psychology of Music Performance Anxiety*. Oxford, UK: OUP Oxford.

Kenny, D. T. (2016a). *Music Performance Anxiety: Theory, Assessment, and Treatment*. Saarbrücken: Lambert Academic Publishing.

Kenny, D. T. (2016b). Short-term psychodynamic psychotherapy (STPP) for a severely performance anxious musician: a case report. *Journal of. Psychol. Psychother*. 6:272. doi: 10.4172/2161-0487.1000272

Kenny, D. T., and Ackermann, B. (2015). Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. *Psychol. Music* 43, 43–60. doi: 10.1177/0305735613493953

Kenny, D. T., and Osborne, M.S. (2006). Music performance anxiety:New insights from young musicians. Advances in Cognitive Psychology 2:103–112.

Kenny, D. T., Arthey, S., and Abbass, A. (2016). Identifying attachment ruptures underlying severe music performance anxiety in a professional musician undertaking an assessment and trial therapy of intensive short-term dynamic psychotherapy (ISTDP). *SpringerPlus* 5:1591. doi: 10.1186/s40064-016-3268-0

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Disord.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kenny, D. T., Driscoll, T., and Ackermann, B. (2012). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T., Driscoll, T., and Ackermann, B. (2016). Is playing in the pit really the pits? Pain, strength, music performance anxiety, and workplace satisfaction in professional musicians in stage, pit, and combined stage/pit orchestras. *Med. Probl. Perform. Art.* 31, 1–7. doi: 10.21091/mppa.2016.1001

Kenny, D. T., Driscoll, T., and Ackermann, B. (2018). Effects of aging on musical performance in professional orchestral musicians. *Medical Problems of Performing Artists* 33, 39–46.

Kenny, D. T., Fortune, J. M., and Ackermann, B. (2013). Predictors of music performance anxiety during skilled performance in tertiary flute players. *Psychol. Music* 41, 306–328. doi: 10.1177/0305735611425904

Kenny, D. T., and Halls, N. (2018). Development and evaluation of two brief group interventions for music performance anxiety in community musicians. *Psychol. Music* 46, 66–83. doi: 10.1177/0305735617702536

Kenny, D. T., and Holmes, J. (2015). Exploring the attachment narrative of a professional musician with severe performance anxiety: a case report. *J. Psychol. Psychother.* 5, 1–6. doi: 10.4172/2161-0487.1000190

Kenny, D. T., and Holmes, J. (2018). Attachment quality is associated with music performance anxiety in professional musicians: an exploratory narrative study. *Pol. Psychol. Bull.* 49, 283–298. doi: 10.24425/119496

Ksondzyk, O. (2020). Kenny music performance anxiety inventory (K-MPAI): exploratory factor analysis of the Ukrainian version. *Ment. Health* 4, 39–44. doi: 10.32437/mhgcj.v4i2.87

Lee, B. E., and Kim, G. H. (2012). Globus pharyngeus: a review of its etiology, diagnosis and treatment. *World J. Gastroenterol.* 18, 2462–2471. doi: 10.3748/wjg.v18.i20.2462

Lin, M. C. (2019). *An Investigation of Music Performance Anxiety in Taiwanese Pianists, Vocalists, String and Wind Instrumentalists at the College Level*. (PhD), The University of North Dakota, USA. Available at: https://commons.und.edu/cgi/viewcontent.cgi?article=3572&context=theses

Mancin, P., Cerea, S., Spoto, A., Gervasi, A., and Ghisi, M. (2022). The 26-item version of the Kenny-music performance anxiety inventory: Italian validation and analysis of its psychometric properties. *Mediterr. J. Clin. Psychol.* 10:40.

Meitei, S. T., and Kumari, S. (2014). Efficacy of cyclic meditation on reducing music performance anxiety in rock musicians. *Int. J. Soc. Sci. Hum. Res.* 2, 126–132.

Oh, S., Yu, E.-R., Lee, H.-J., and Yoon, D.-U. (2020). Reliability and validity of the Korean version of the Kenny music performance anxiety inventory. *J. Korean Neuropsychiatr. Assoc.* 59, 250–259. doi: 10.4306/jknpa.2020.59.3.250

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., Rodríguez-Ledo, C., and Mazas, B. (2017). The relation of music performance anxiety (MPA) to optimism, self-efficacy, and sensitivity to reward and punishment: testing Barlow's theory of personal vulnerability on a sample of Spanish music students. *Psychol. Music* 45, 570–583. doi: 10.1177/0305735616674791

Osborne, M. S., and Kenny, D. T. (2008). The role of sensitizing experiences in music performance anxiety in adolescent musicians. *Psychol. Music* 36, 447–462. doi: 10.1177/0305735607086051

Paliaukiene, V., and Kairys, A. (2012). Muzikos atlikimo patirties ir lyties sqsajos su atlikimo nerimu. [music performance experience and gender links with performance anxiety]. *Lietuvos Muzikologija* 13, 22–38.

Paliaukiene, V., Kazlauskas, E., Eimontas, J., and Skeryte-Kazlauskiene, M. (2018). Music performance anxiety among students of the academy in Lithuania. *Music. Educ. Res.* 20, 390–397. doi: 10.1080/14613808.2018.1445208

Papageorgi, I. (2022). Prevalence and predictors of music performance anxiety in adolescent learners: contributions of individual, task-related and environmental factors. *Music. Sci.* 26, 101–122. doi: 10.1177/1029864920923128

Papageorgi, I., Creech, A., and Welch, G. (2011). Perceived performance anxiety in advanced musicians specializing in different musical genres. *Psychol. Music* 41, 18–41. doi: 10.1177/0305735611408995

Peschke, S., and von Georg, R. (2015). *The Competence of Performance: Mental Aspects of Succeeding and Failing in Musicians*. Manchester, UK: Paper Presented at the Ninth Triennial Conference of the European Society for the Cognitive Sciences of Music.

Plaut, E. A. (1990). Psychotherapy of performance anxiety. *Med. Probl. Perform. Art.* 5, 58–63.

Porges, S. W. (2001). The polyvagal theory: phylogenetic substrates of a social nervous system. *Int. J. Psychophysiol.* 42, 123–146. doi: 10.1016/S0167-8760(01)00162-3

Porges, S. W. (2007). The polyvagal perspective. *Biol. Psychol.* 74, 116–143. doi: 10.1016/j.biopsycho.2006.06.009

Porges, S. W. (2011). *The Polyvagal Theory: Neurophysiological Foundations of Emotions, Attachment, Communication, and Self-regulation Norton Series on Interpersonal Neurobiology*. WW Norton and Company.

Rauf, R. M. U., and Laitf, F. A. (2018). Evaluating the Kenny music performance anxiety inventory (K-MPAI) on tertiary students in Malaysia. *Malays. J. Soc. Sci. Hum.* 3, 14–24. doi: 10.47405/mjssh.v3i1.54

Robson, K. E., and Kenny, D. T. (2017). Music performance anxiety in ensemble rehearsals and concerts: a comparison of music and non-music major undergraduate musicians. *Psychol. Music* 45, 868–885. doi: 10.1177/0305735617693472

Rocha, S. F., Dias-Neto, E., and Gattaz, W. F. (2011). Music performance anxiety: translation, adaptation and validation of the Kenny music performance anxiety inventory (K-MPAI) to the Portuguese language. *Rev. Psiquiatr. Clín.* 38, 217–221. doi: 10.1590/S0101-60832011000600001

Ružak, T. (2021). *Psihološki Aspekti Izvođačke Anksioznosti kod Glazbenika i Dramskih Umjetnika*. University of Zagreb: Academy of Music. Music Pedagogy Department.

Shaver, P. R., Mikulincer, M., Lavy, S., and Cassidy, J. (2009). "Understanding and altering hurt feelings: an attachment-theoretical perspective on the generation and regulation of emotions" in *Feeling Hurt in Close Relationships*. ed. A. L. Vangelisti (Cambridge: Cambridge University Press), 92–119.

Sickert, C., Klein, J. P., Altenmüller, E., and Scholz, D. S. (2022). Low self-esteem and music performance anxiety can predict depression in musicians. *Med. Probl. Perform. Art.* 37, 213–220. doi: 10.21091/mppa.2022.4031

Spielberger, C. D. (1983). *State-trait Anxiety Inventory STAI*. Palo Alto, CA: Consulting Psychologists Press.

Spitzer, R. L., Kroenke, K., and Williams, J. B. (2003). *The Primary Care Evaluation of Mental Disorders (PRIME-MD)*.

van Fenema, E. M., Gal, P., van de Griend, M. V., Jacobs, G. E., and Cohen, A. F. (2017). A pilot study evaluating the physiological parameters of performance-induced stress in undergraduate music students. *Digit. Biomark.* 1, 118–125. doi: 10.1159/000485469

Weisblatt, S. (1986). A psychoanalytic view of performance anxiety. *Med. Probl. Perform. Art.* 1, 64–67.

Wiedemann, A., Vogel, D., Voss, C., and Hoyer, J. (2022). How does music performance anxiety relate to other anxiety disorders? *Psychol. Music* 50, 204–217. doi: 10.1177/0305735620988600

Wiedemann, A., Vogel, D., Voss, C., Nusseck, M., and Hoyer, J. (2020). The role of retrospectively perceived parenting style and adult attachment behaviour in music performance anxiety. *Psychol. Music* 48, 707–723. doi: 10.1177/0305735618817877

Yoder, E. S. (2022). *Music Performance Anxiety in School Band Directors*. ProQuest Dissertations.

Zarza-Alzugaray, F. J., Hernández, S. O., López, O. C., and Gil, B. M. (2015). Kenny music performance anxiety inventory: confirmatory factor analysis of the Spanish version. *Psychol. Music* 44, 340–352. doi: 10.1177/0305735614567932

Zarza-Alzugaray, F. J., Casanova, O., McPherson, G. E., and Orejudo, S. (2020). Music self-efficacy for performance: an explanatory model based on social support. *Front. Psychol.* 11:1249. doi: 10.3389/fpsyg.2020.01249

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Symptoms of and coping strategies for music performance anxiety through different time periods

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Music performance anxiety (MPA) manifests itself at mental, physiological, and behavioral levels. The present study investigated how the experience of the three levels of symptoms changes over time, and how musicians cope with these temporal changes in MPA symptoms. To this end, we conducted a questionnaire survey in which 38 student musicians freely commented on their experiences of mental and physical changes, as well as their coping strategies for these changes. This was examined during five different time periods around public performance, extending from the beginning of the preparation for a public performance until shortly before the next public performance. The free-text comments obtained from the questionnaire were analyzed thematically and classified into different response themes. We then examined the temporal changes in the frequency of comments on each response theme. We further conducted a semi-structured interview involving eight musicians to explore the responses to the questionnaire in greater detail. We analyzed the contents of the free-text comments obtained from the questionnaire and the interview for each response theme, focusing on the most frequently mentioned sub-themes. The results indicate that musicians started to experience mental MPA symptoms (e.g., negative feelings) as soon as they began to prepare for public performance. To cope with mental symptoms, musicians employed mental strategies such as positive thinking/self-talk and concentration both before and during public performance. The experience of physiological MPA symptoms (e.g., increased heart rate) peaked shortly before public performance and remained throughout performance. To cope with a variety of physiological symptoms, musicians employed physical strategies, especially deep breathing and exercise, shortly before public performance. In contrast, behavioral MPA symptoms (e.g., tremor) were experienced mostly during public performance. Some musicians also reported experiencing the actual impairment of performance quality. To avoid this, musicians employed a variety of practicing techniques (e.g., playing at a slower tempo) during the preparation for public performance and performing techniques (e.g., paying attention to expressions) during public performance. Together, the present findings indicate that mental, physiological, and behavioral symptoms of MPA exhibit differential timelines and that musicians effectively utilize different coping strategies according to the temporal changes in MPA symptoms.

KEYWORDS

music performance anxiety, stage fright, symptom, coping strategy, musician, pianist, emotion

1. Introduction

Music performance anxiety (MPA) is a significant problem for most music performers. MPA has been defined as "the experience of persisting, distressful apprehension about and/or actual impairment of, performance skills in a public context, to a degree unwarranted given the individual's musical aptitude, training, and level of preparation" (Salmon, 1990, p. 3). Previous surveys indicate a high prevalence of MPA among musicians (Fishbein et al., 1988; Wesner et al., 1990; van Kemenade et al., 1995; Yoshie et al., 2011). For example, 58.7% of professional musicians playing in symphonic orchestras in the Netherlands reported experiencing MPA (van Kemenade et al., 1995). In another survey, 63.9% of Japanese classical musicians reported being troubled with MPA (Yoshie et al., 2011). MPA afflicts not only professional but also student musicians (Kaspersen and Gotestam, 2002; Fehm and Schmidt, 2006; Zakaria et al., 2013; Paliaukiene et al., 2018; Zarza-Alzugaray et al., 2018; Sickert et al., 2022). A recent survey found that 96% of undergraduates studying music were suffering from MPA (Zakaria et al., 2013). Moreover, 36.5% of music students reported a need for help with MPA (Kaspersen and Gotestam, 2002). MPA negatively influences musicians' careers (van Kemenade et al., 1995; Fehm and Schmidt, 2006), and can sometimes force student musicians to abandon their musical studies (Orejudo Hernández et al., 2018). In light of the prevalence and severity of the problem, it is important for young student musicians to develop and establish their own highly effective coping strategies for MPA.

The symptoms of MPA are categorized into three groups: mental, physiological, and behavioral (Salmon, 1990; Steptoe, 2001; Burin and Osório, 2017). The *mental* symptoms involve the experience of negative emotions such as anxiety and cognitive problems such as memory slips (Steptoe, 2001; Yoshie et al., 2008b, 2009c). The *physiological* symptoms involve changes in physiological states, such as increased heart rate and perspiration (Salmon, 1990; Steptoe, 2001; Yoshie et al., 2008a, 2009a,b). The *behavioral* symptoms involve visible changes in musicians' behavior, such as tremor and the impairment of performance quality (Steptoe, 2001; Yoshie et al., 2008a, 2009a,b; Burin and Osório, 2017; Kotani and Furuya, 2018).

Previous studies examining the three types of MPA symptoms mainly focused on the mental or physical changes that appear shortly before or during public performance (Brotons, 1994; Yoshie et al., 2008a,b, 2009a,c; Kotani and Furuya, 2018). However, several pieces of evidence suggest that MPA symptoms can persist for a longer period of time around public performance. The survey by van Kemenade et al. (1995) demonstrated that professional musicians can suffer from MPA weeks or even months prior to a performance. More recently, Zakaria et al. (2013) showed that most student musicians experience MPA before and during public performance, but that some of them also experience it after performance. Furthermore, Papageorgi et al. (2013) demonstrated that the level of MPA reaches a peak shortly before public performance, and decreases during performance. Although these studies effectively show that the level of MPA can vary across different time periods around public performance, it is still unknown how the mental, physiological, and behavioral symptoms of MPA change over time.

To address this, we adopted a qualitative approach in which musicians' responses to open questions in a questionnaire survey and those in a semi-structured interview were analyzed thematically. Previous surveys on MPA typically asked musicians to answer a fixed set of closed questions to indicate how often (or how strongly) they experienced each MPA symptom, and their responses were analyzed quantitatively and often statistically (Wolfe, 1989; Kenny et al., 2004; Osborne and Kenny, 2005; Yoshie et al., 2008b, 2009c; Kobori et al., 2011). This quantitative approach has been successfully elucidating psychological mechanisms underlying MPA. However, the approach contains a limitation in that it does not allow researchers to determine which of the three types of MPA symptoms dominates within a musician's subjective experience during a given time period around public performance. We thus asked student musicians to describe the mental and physical changes that they experienced during five different time periods around public performance. The contents of the free-text comments from the respondents were then analyzed to identify different response themes, including the three types of MPA symptoms. As in previous qualitative research (Franzosi, 2004; Alhija and Fresko, 2009; Maisonneuve et al., 2014), we analyzed the frequency of comments within each response theme to investigate the timelines of the three types of MPA symptoms around public performance. We then analyzed the contents of comments with a focus on the most frequently mentioned sub-themes for each response theme.

Previous literature suggests that musicians employ a variety of coping strategies to mitigate MPA, such as self-talk, cognitive restructuring, deep breathing, and practicing techniques (Fehm and Schmidt, 2006; Su et al., 2010; Studer et al., 2011; Hoffman and Hanrahan, 2012; Zhukov, 2019; Huang and Song, 2021). A recent study effectively demonstrated that musicians choose to use different coping strategies in different time periods around public performance (Huang and Song, 2021). However, it is still unclear whether/how musicians modulate their coping strategies according to the timelines of mental, physiological, and behavioral MPA symptoms. To address this, the questionnaire also asked student musicians to describe how they coped with the mental/physical changes during different time periods around public performance. We then analyzed the free-text comments thematically with an inductive (i.e., codebook) approach (Braun and Clarke, 2006). This approach enabled us to identify three response themes for coping strategies: mental, physical, and performance strategies. We analyzed the frequency of comments within each response theme to investigate the timelines of the three types of coping strategies around public performance. Here again, we analyzed the contents of comments with a focus on the most frequently mentioned sub-themes for each response theme.

Since semi-structured interviews are useful for exploring participants' thoughts and feelings about a specific topic in detail (Dejonckheere and Vaughn, 2019), we further conducted a semi-structured interview involving both student and professional musicians. In the three-hour interview sessions, we asked participants to give us more details about their experiences related to MPA

Abbreviations: MPA, music performance anxiety; P1, time period 1 (from the beginning of the preparation for a public performance until the day before the performance); P2, time period 2 (from the morning of the performance day until shortly before going onstage); P3, time period 3 (during the public performance); P4, time period 4 (from shortly after going offstage until the end of the performance day); P5, time period 5 (from the next day of the performance until shortly before the next public performance).

symptoms and coping strategies. We also compared the interview data between student and professional musicians to examine whether there were any differences in the experience of MPA symptoms and related coping strategies.

2. Materials and methods

2.1. Participants

Thirty-eight undergraduate and postgraduate students (34 females, $M_{age} \pm SD = 20.5 \pm 1.7$ years) majoring in music performance (12 students) or music education (26 students) at two universities in Japan participated in a questionnaire survey. Out of the 38 students, 29 reported majoring in piano, three reported majoring in singing and piano, three reported majoring in singing, two reported majoring in wind instruments, and one reported majoring in a string instrument. On average, participants started to play their major instrument at the age of 5.7 ± 4.2 years.

Since a previous survey in Japan demonstrates that pianists are most likely affected by MPA among different types of musicians (Yoshie et al., 2011), we focused on pianists in a following semi-structured interview. Participants were chosen from the group of students majoring in music performance (12 students), which included nine pianists. Two out of the nine pianists who played popular music in addition to classical music were excluded, and the remaining seven potential interviewees played classical music only. Based on their availability and willingness to participate in a follow-up study, five female student pianists ($M_{age} \pm SD = 19.4 \pm 2.1$ years) took part in the interview to report more details about their experiences related to MPA symptoms and coping strategies. To compare the responses from students with those from more experienced musicians, we additionally invited three professional pianists (one female, $M_{age} \pm SD = 62.0 \pm 1.7$ years) to the semi-structured interview. The professional pianists had been performing for an average of 57.0 ± 1.0 years and had studied music performance both in Japan and in Europe. Since the available sample was small, we did not apply any additional exclusion criteria such as the use of medication.

This study was approved by the National Institute of Advanced Industrial Science and Technology (AIST) Ethics Committee. All participants gave written informed consent.

2.2. Design and procedure

2.2.1. Questionnaire survey

We asked 38 participants to recall their past public performances in general and to answer two open-ended questions about these performances: (1) what changes in mental and physical states they experienced and (2) how they coped with these mental and physical changes. Participants gave answers to these two questions for five different time periods around public performance: (1) from the beginning of the preparation for a public performance until the day before the performance (*P1*), (2) from the morning of the performance day until shortly before going onstage (*P2*), (3) during the public performance (*P3*), (4) from shortly after going offstage until the end of the performance day (*P4*), and (5) from the next day of the performance until shortly before the next public performance (*P5*).

2.2.2. Semi-structured interview

We interviewed each of the eight participants (five students and three professional pianists) in either one three-hour session or in two 90-min sessions. In the semi-structured interview, we asked all participants the same questions in the same order to ensure that the data collected were comparable (McIntosh and Morse, 2015), although participants were allowed flexibility in responding to the questions. As in the questionnaire survey, we asked participants: (1) what changes in mental and physical states they experienced and (2) how they coped with these mental and physical changes. During the interview, participants could refer to a list of typical MPA symptoms derived from previous literature. The interview also included participants' brief history of piano performance and the transitions of MPA in their performing life. All the interviews were conducted in Japanese and audio-recorded with the permission of participants.

2.3. Data analyses

2.3.1. Qualitative analyses

For both the questionnaire and the interview, all comments regarding the changes in mental and physical states were transcribed and then analyzed thematically. The comments were classified into five response themes: (1) mental (i.e., cognitive or emotional) MPA symptoms, (2) physiological MPA symptoms, (3) behavioral MPA symptoms, (4) positive states/changes, and (5) others, based on previous literature (Salmon, 1990; Steptoe, 2001; Yoshie et al., 2011; Burin and Osório, 2017). Subsequent analyses focused on the first four response themes. Although some of the reported symptoms (e.g., tremor) could be viewed as both physiological and behavioral (Wesner et al., 1990; Steptoe, 2001; Burin and Osório, 2017; Fernholz et al., 2019), we classified all the visible changes in musicians' behavior as behavioral MPA symptoms (Steptoe, 2001; Burin and Osório, 2017).

All comments about coping strategies toward MPA were analyzed thematically as an inductive approach. In the process of the thematic analysis, we applied a codebook approach using an initial codebook with themes derived from previous literature and developed it to generate codes and themes from the data (Braun and Clarke, 2006). The coded comments were progressively refined for further sub-themes based on the coping strategies defined in previous literature. As a result, three response themes were identified for coping strategies: (1) mental strategies, (2) physical strategies, and (3) performance strategies. The categorization criteria were as follows: First, any strategies that were directly related to music performance or practice were classified into *performance* strategies. Second, out of the remaining strategies, those aimed at modifying musicians' physical state were classified into *physical* strategies. Third, since all the remaining strategies aimed at modifying musicians' cognitive and/or emotional state, they were classified into *mental* strategies.

To ensure the validity of the classifications, one researcher classified the data into themes, and then the other two researchers overviewed and considered the outcomes. In the process of coding, all three researchers reviewed the generated themes and then ensured consistency in the decisions and interpretations made. When we needed to cite an example of a comment from the questionnaire or interview data, one researcher translated it into English. Subsequently, another researcher reviewed the translation, and the two researchers modified it together, when necessary.

2.3.2. Quantitative analyses

For the questionnaire data, we counted the number of comments classified into each response theme for each of the five time periods (i.e., P1-P5) for each participant. The number of comments was first analyzed with two-way analyses of variance (ANOVA) of theme × period. Since the two-way interaction was found to be significant both for the mental/physical changes and coping strategies, we subsequently examined the interactions by performing a follow-up one-way ANOVA of the period for each theme. In all ANOVAs, Greenhouse–Geisser correction was applied to the degrees of freedom where the sphericity assumption was violated.

3. Results and discussion

This study aimed to investigate how the three types of MPA symptoms change over time around public performance and how musicians cope with these changes. To this end, we combined a questionnaire survey with a semi-structured interview to ask musicians to report their experiences of any mental/physical changes during five different time periods around past public performances and their strategies for coping with these changes.

3.1. Temporal changes in mental/physical states around public performance

In the questionnaire survey, the number of participants (out of the 38 student musicians) who wrote at least one comment on the mental, physiological, behavioral symptoms of MPA, or positive states/changes was 33, 21, 22, and 28, respectively (Table 1). Thus, student musicians recognized the mental symptoms most frequently out of the three types of MPA symptoms.

A two-way ANOVA of theme × period on the number of comments (Figure 1A) revealed a significant interaction effect (F (6.58, 243.36) = 11.41, p < 0.001, partial η^2 = 0.24), in addition to a significant main effect of the theme (F (2.54, 93.86) = 9.52, p < 0.001, partial η^2 = 0.21) and of the period (F (3.61, 133.59) = 17.12, p < 0.001, partial η^2 = 0.32). The follow-up one-way ANOVAs for each of the four themes revealed a significant main effect of the period for mental MPA symptoms (F (2.81, 103.86) = 11.62, p < 0.001, partial η^2 = 0.24), physiological MPA symptoms (F (1.80, 66.76) = 13.73, p < 0.001, partial η^2 = 0.27), behavioral MPA symptoms (F (2.57, 95.12) = 9.70, p < 0.001, partial η^2 = 0.21), and positive states/changes (F (2.89, 106.71) = 13.44, p < 0.001, partial η^2 = 0.27), respectively. Therefore, we subsequently conducted *post hoc* Bonferroni multiple comparisons for each of the four themes to explore the origin of the main effect.

3.1.1. Mental MPA symptoms

The questionnaire data showed that the number of comments on mental MPA symptoms peaked in P2, gradually decreasing toward P5 (Figure 1B). The *post hoc* multiple comparisons for mental MPA symptoms demonstrated that the number of comments for P1 was significantly greater than that for P4 (p = 0.019) and P5 (p < 0.001). The number of comments for P2 was also greater than that for P4 (p < 0.001) and P5 (p < 0.001). These results suggest that mental MPA symptoms were recognized by student musicians mainly *before* public performance. All the comments for P1 (20 participants) and P2 (23 participants) mentioned the experience of negative feelings such as anxiety and nervousness (Table 1). For example:

> "As the performance day approaches, I start to imagine the performance situation and get nervous little by little." (a student)

In P3, 10 participants reported experiencing negative feelings and five participants reported experiencing cognitive problems such as memory slips (Table 1). A typical example of memory slips was as follows:

> "I sometimes forget what I should play next during a public performance." (a student)

A few participants experienced negative feelings such as anxiety and depression even after public performance (P4 and P5). This timeline complies with previous findings indicating that most musicians experience MPA before and during public performance (Papageorgi et al., 2013; Zakaria et al., 2013).

Consistent with the results of the questionnaire, the interview participants also reported experiencing negative feelings such as anxiety and nervousness mainly in P1 and P2. The interview data indicated that there were two psychological factors underlying their negative feelings: the concern over mistakes and the fear of negative evaluation by others. All five students reported that they worried about making mistakes, which exacerbated their anxiety. For example:

> "I was worried about mistakes. Well, I made mistakes on the certain part where I did not want to make mistakes. If I make mistakes at the climax part or conspicuous part, I feel 'Oh no'…" (a student)

> "I could not imagine my performance would be going well. I seriously thought that I should not make mistakes." (a student)

All five students were also sensitive about how their performance would be evaluated by their teachers, family, friends, colleagues, or audiences. For example:

> "(describing a competition) As even I slightly feel like, 'Oh, that person's performance has changed from before,' I understand that I could be thought of like this by others, too. So, I do not like for people to think, 'Her performance sounds like she did not practice enough this time' or something like this… well, [I worry about] evaluation from others." (a student)

> "I unintentionally pressured myself when I started thinking how much my parents did to lead me to this stage; for example, driving for a couple of hours for my piano competition… I did not think until the public performance, but I realized on the performance day that I got more nervous than I thought." (a student)

Previous questionnaire surveys indicate that perfectionistic thinking, especially the concern over mistakes, increases subjective anxiety or distress in musicians (Stoeber and Eismann, 2007; Yoshie and Shigemasu, 2007; Kobori et al., 2011). Furthermore, the

TABLE 1 Number of participants commenting on each theme of mental/physical changes in the questionnaire survey.

Theme	Sub-theme	Number (and percentage) of participants					
		P1	P2	P3	P4	P5	P1-P5
Mental symptoms	Negative feelings	20 (52.6)	23 (60.5)	10 (26.3)	7 (18.4)	3 (7.9)	**32 (84.2)**
	Cognitive problems	0 (0.0)	0 (0.0)	5 (13.2)	0 (0.0)	1 (2.6)	**6 (15.8)**
	Total	**20 (52.6)**	**23 (60.5)**	**14 (36.8)**	**7 (18.4)**	**4 (10.5)**	**33 (86.8)**
Physiological symptoms	Increased heart rate	0 (0.0)	13 (34.2)	6 (15.8)	1 (2.6)	0 (0.0)	**16 (42.1)**
	Perspiration	0 (0.0)	5 (13.2)	2 (5.3)	0 (0.0)	0 (0.0)	**7 (18.4)**
	Cold hands	0 (0.0)	3 (7.9)	1 (2.6)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Gastrointestinal disturbances	1 (2.6)	3 (7.9)	0 (0.0)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Sleep disturbances	1 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**1 (2.6)**
	Hot flash	0 (0.0)	0 (0.0)	1 (2.6)	0 (0.0)	0 (0.0)	**1 (2.6)**
	Total	**2 (5.3)**	**17 (44.7)**	**9 (23.7)**	**1 (2.6)**	**0 (0.0)**	**21 (55.3)**
Behavioral symptoms	Tremor	0 (0.0)	3 (7.9)	10 (26.3)	3 (7.9)	0 (0.0)	**13 (34.2)**
	Muscle stiffness	1 (2.6)	1 (2.6)	5 (13.2)	0 (0.0)	0 (0.0)	**6 (15.8)**
	Impairment of performance quality	1 (2.6)	0 (0.0)	3 (7.9)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Overtraining	2 (5.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.6)	**3 (7.9)**
	Floating feeling	0 (0.0)	0 (0.0)	1 (2.6)	1 (2.6)	0 (0.0)	**1 (2.6)**
	Total	**4 (10.5)**	**3 (7.9)**	**17 (44.7)**	**4 (10.5)**	**1 (2.6)**	**22 (57.9)**
Positive states/ changes	Positive feelings	3 (7.9)	2 (5.3)	4 (10.5)	21 (55.3)	9 (23.7)	**24 (63.2)**
	Disappearance of MPA symptoms	0 (0.0)	0 (0.0)	4 (10.5)	3 (7.9)	0 (0.0)	**7 (18.4)**
	Improvement of concentration	0 (0.0)	0 (0.0)	3 (7.9)	0 (0.0)	0 (0.0)	**3 (7.9)**
	Positive behaviors	1 (2.6)	0 (0.0)	2 (5.3)	0 (0.0)	0 (0.0)	**3 (7.9)**
	Total	**4 (10.5)**	**2 (5.3)**	**11 (28.9)**	**23 (60.5)**	**9 (23.7)**	**28 (73.7)**

The values in parentheses show the percentages of participants within the present sample. The bold "Total" values indicate the numbers (and percentages) of participants commenting on at least one of the sub-themes for each theme. The bold "P1-P5" values indicate the numbers (and percentages) of participants commenting for at least one of the time periods. P1, time period 1 (from the beginning of the preparation for a public performance until the day before the performance); P2, time period 2 (from the morning of the performance day until shortly before going onstage); P3, time period 3 (during the public performance); P4, time period 4 (from shortly after going offstage until the end of the performance day); P5, time period 5 (from the next day of the performance until shortly before the next public performance).

interaction between the concern over mistakes and the fear of negative evaluation by audiences was found to further exacerbate subjective anxiety in pianists (Yoshie and Shigemasu, 2007). The interview data obtained from student musicians are consistent with these previous findings. Meanwhile, none of the professional pianists mentioned making mistakes or negative evaluations as being a serious issue, which may have been helpful in alleviating their anxiety.

Four students and two professionals reported having anxiety over memorizing music in P1 and P2. For example:

> "Playing from memory is not the first thing to worry about, but it is always an underlying worry for a performance." (a professional pianist)

Two students and all three professionals also reported having experienced memory slips as a cognitive symptom in P3. For example:

> "It was traumatic. I stopped playing (during the performance) and my mind went blank… It became traumatic that I actually forgot the piece and stopped playing." (a student)

These comments suggest that memorizing music is another source of anxiety in public performance.

In P4 and P5, although student musicians reported experiencing burnout, professionals could switch their feelings shortly after public performance. Compared to professionals, student musicians tended to experience mental MPA symptoms for a longer period of time, extending from the beginning of the preparation for a public performance until days or even weeks after the performance.

3.1.2. Physiological MPA symptoms

The questionnaire data showed that the number of comments on physiological MPA symptoms peaked in P2, gradually decreasing toward P5 (Figure 1C). The *post hoc* multiple comparisons for physiological MPA symptoms demonstrated that the number of comments for P2 was significantly greater than that for P1 ($p = 0.003$), P4 ($p < 0.001$), and P5 ($p < 0.001$), respectively. In addition, the number of comments for P3 was significantly greater than that for P5 ($p = 0.026$). Therefore, physiological MPA symptoms were mainly recognized *shortly before* and *during* public performance. The most frequently mentioned symptom was increased heart rate, with 13 participants reporting it in P2 and 6 participants in P3 (Table 1). For example:

> "My heart beats faster just before public performance." (a student)

Other frequently mentioned symptoms included perspiration, cold hands, and gastrointestinal disturbances (Table 1).

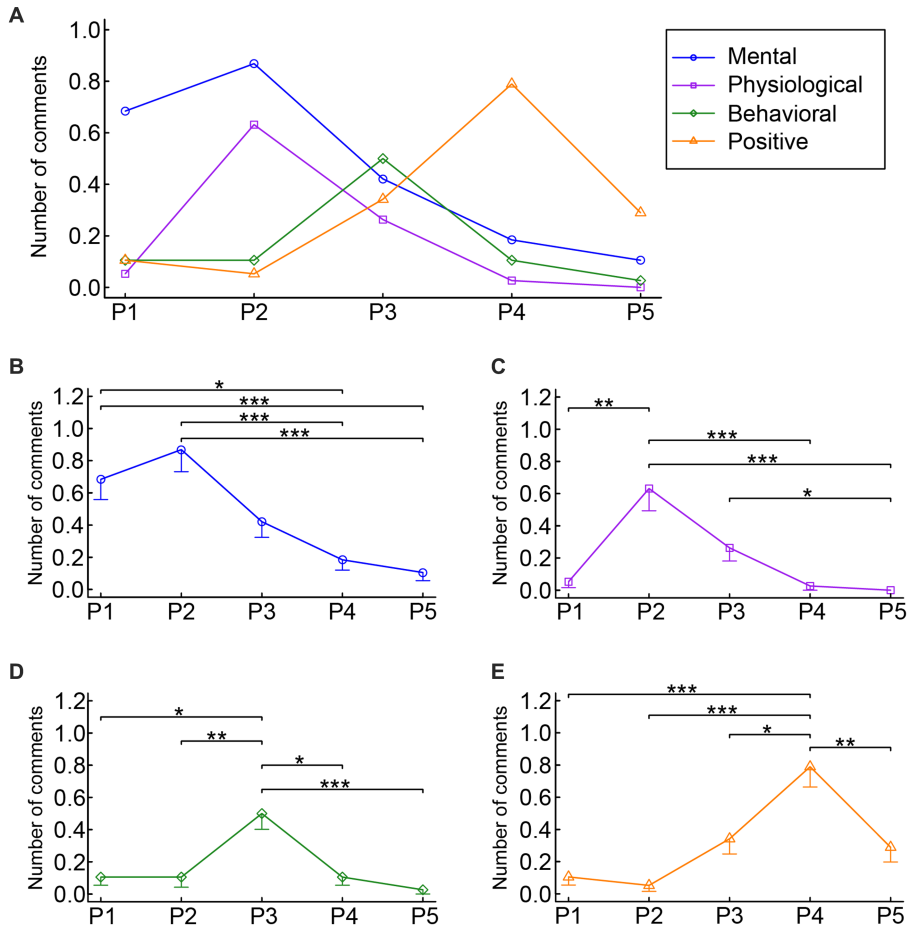

FIGURE 1
Mean number of comments for mental, physiological, behavioral MPA symptoms and positive states/changes. **(A)** Summary of the results. **(B–E)** Results of the statistical analyses for mental, physiological, behavioral MPA symptoms and positive states/changes, respectively. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The error bars represent standard errors of the mean. P1: time period 1 (from the beginning of the preparation for public performance until the day before the performance). P2: time period 2 (from the morning of the performance day until shortly before going onstage). P3: time period 3 (during the public performance). P4: time period 4 (from shortly after going offstage until the end of the performance day). P5: time period 5 (from the next day of the performance until shortly before the next public performance).

In the interview, all five students and two professionals reported experiencing increased heart rate mainly in P2 and P3. For example:

> "I often feel that my heart beats faster… Definitely heart beats get faster, absolutely. Absolutely it happens, of course." (a professional pianist)

The results show that most participants recognized increased heart rate shortly before and during public performance. This finding is consistent with previous psychophysiological experiments demonstrating that musicians' heart rate dramatically increases during public performance compared to practice or rehearsals (Fredrikson and Gunnarsson, 1992; Brotons, 1994; Yoshie et al., 2009a).

All five students and two professionals also reported experiencing cold hands/body. For example:

> "My hands were cold." (a student)

Four students and one professional pianist reported experiencing sleep and gastrointestinal disturbances. Notably, student musicians reported experiencing anorexia before public performance. For example:

> "I could not sleep well when I felt that I did not practice enough." (a professional pianist)

> "I can eat in the morning, but just before a performance, I cannot eat much. I can manage to drink like jelly beverage, but for example, bread… maybe not." (a student)

The physiological symptoms reported here were all consistent with those reported in previous studies (Salmon, 1990; Steptoe, 2001; Yoshie et al., 2008a, 2009a,b). Interestingly, both the experience of negative feelings and the recognition of physiological symptoms peaked shortly before public performance (Figures 1B,C), supporting

previous findings (Papageorgi et al., 2013; Zakaria et al., 2013). This may highlight the important role of bodily responses in the experience of anxiety (Critchley, 2005). Two professionals looked back on their youth and reported that they used to have more physiological symptoms, such as sweaty palms and gastrointestinal disturbances. This complies with previous studies suggesting that many years of performance experience can sometimes lead to a reduction in MPA (Steptoe and Fidler, 1987; Osborne and Franklin, 2002).

Interestingly, student and professional musicians differed in the way they perceived physiological MPA symptoms. Student musicians tended to perceive physiological symptoms negatively, which could aggravate their subjective anxiety. For example:

> "My hands get very cold before going onstage, but they get sweaty onstage. I then feel like 'I want to go home' almost every time…" (a student)

In contrast, professional musicians perceived physiological symptoms as an unharmful response, or even as a positive response that can enhance performance quality. For example:

> "… well, I feel that my heart beats faster. But I would not make mistakes because of that. I just keep on going, taking it as it comes." (a professional pianist)

> "As for perspiration, I think it's good to warm up my body until I start to sweat. Otherwise, my body would not move properly. So, it's natural to sweat a bit." (a professional pianist)

Previous literature suggests that physiological MPA symptoms can facilitate music performance in certain conditions (Hamann and Sobaje, 1983; Roland, 1994; Gannon, 2019). In particular, musicians with considerable experience and expertise are likely to properly control their physiological symptoms and utilize them to enhance focus, excitement, and performance quality (Roland, 1994; Gannon, 2019). This might explain why professional pianists reported viewing physiological MPA symptoms as a positive part of performing in the present interview.

Another difference between students and professionals was found in the onset of physiological symptoms. Although student musicians started to experience physiological symptoms during the preparation for public performance, professional pianists rarely recognized physiological symptoms in this time period. Therefore, similarly to mental symptoms, students tended to experience physiological symptoms for a longer time compared to professionals.

3.1.3. Behavioral MPA symptoms

The questionnaire data showed that the experience of behavioral MPA symptoms peaked in P3. The *post hoc* multiple comparisons for behavioral MPA symptoms demonstrated that the number of comments for P3 was significantly greater than that for P1 ($p = 0.01$), P2 ($p = 0.002$), P4 ($p = 0.01$), and P5 ($p < 0.001$), respectively. The results indicate that behavioral MPA symptoms were mainly recognized *during* public performance. The most frequently mentioned symptom in P3 was tremor, with 10 participants mentioning it (Table 1). For example:

> "I get so nervous that my hands and feet tremble." (a student)

Some participants reported that they experienced tremor even shortly before (three participants) and shortly after (three participants) public performance (Table 1).

The second most frequently mentioned symptom in P3 was muscle stiffness, with five participants mentioning it (Table 1). For example:

> "I feel that my body is stiff." (a student)

Additionally, three participants reported experiencing the actual impairment of performance quality in P3 (Table 1). For example:

> "Although I try to produce the same sounds as those during practice, my fingers would not move well." (a student)

Supporting the results of the questionnaire, the most frequently mentioned behavioral symptoms in the interview were muscle stiffness, tremor, and the impairment of performance quality. All eight participants of the interview reported having experienced muscle stiffness. For example:

> "My body became stiff. I also realized that it affected my tone quality, which sounded hard… I was told to relax my body, but my shoulder was so stiff. I had no idea how to relax my body and release body tension." (a student)

Furthermore, all five students and one professional pianist reported having experienced tremor. For example:

> "My foot was trembling on the pedal." (a professional pianist)

Both students and professional pianists reported experiencing these behavioral MPA symptoms in P3, but only students reported experiencing them in P2 as well.

Furthermore, all eight participants of the interview reported that their performance quality was sometimes impaired in P3. They reported making a variety of technical and artistic mistakes, such as melodic inaccuracies, unbalanced rhythm, rapid tempo, and inappropriate tone quality. For example:

> "I played a wrong note at the end… that was the biggest mistake… my body was stiff, and the tone color was hard, too…" (a student)

> "My performance got faster and faster… as like slipping. I felt like sliding on the ice." (a professional pianist)

The behavioral symptoms reported here were consistent with those reported in previous studies (Salmon, 1990; Steptoe, 2001; Yoshie et al., 2008a, 2009a,b; Kotani and Furuya, 2018). Both tremor and muscle stiffness can have detrimental effects on performance quality. Involuntary tremor of various body parts (e.g., hands, fingers, and feet) would disturb the fine motor control of musicians. Muscle stiffness, which could be related to heightened muscle activity and increased co-contraction levels of antagonistic muscles (Yoshie et al., 2009a), can adversely affect musical expressions by disrupting the subtle control of loudness (Yoshie et al., 2008a) and the maintenance of temporal continuity (Drake and Palmer, 2000). These behavioral symptoms would thus lead to a decrease in the sense of control

(Guyon et al., 2022) and the actual impairment of performance quality (Yoshie et al., 2009a; Sokoli et al., 2022) during public performance.

Interestingly, behavioral MPA symptoms followed a timeline that was independent from the timeline of mental or physiological symptoms. The behavioral symptoms were recognized most frequently onstage, whereas mental and physiological symptoms were recognized most frequently shortly before public performance.

Here again, we found some differences in the experience of behavioral MPA symptoms between students and professionals. First, similarly to mental and physiological symptoms, students experienced behavioral symptoms for a longer time than did professionals: although professionals experienced behavioral symptoms only onstage, students tended to experience them throughout the performance day. Second, similarly to physiological symptoms, students perceived behavioral symptoms more negatively compared to professionals. Notably, students tended to perceive the impairment of performance quality as traumatic, while professionals felt that some mistakes are common and acceptable during public performance. The way of perceiving behavioral symptoms specific to students could aggravate their subjective anxiety.

3.1.4. Positive states/changes

The number of comments on positive states/changes peaked in P4 (Figure 1E). The *post hoc* multiple comparisons for positive states/changes showed that the number of comments for P4 was significantly greater than that for P1 ($p < 0.001$), P2 ($p < 0.001$), P3 ($p = 0.037$), and P5 ($p = 0.003$), respectively. Therefore, the experience of MPA symptoms was replaced by that of positive states/changes shortly after public performance. In P4, 21 out of the 38 participants reported experiencing positive feelings such as relief and achievement (Table 1). For example:

> "I feel relieved when a performance ends without any accidents." (a student)

The experience of similar positive feelings was also reported by nine participants in P5. Furthermore, three participants reported the disappearance of MPA symptoms in P4 (Table 1). For example:

> "I feel myself letting go of tension." (a student)

Notably, 11 participants reported experiencing positive states/changes even in P3 or during public performance (Table 1). Their comments included the experience of positive feelings (four participants), the disappearance of MPA symptoms (four participants), and the improvement of concentration (three participants). For example:

> "I enjoy music performance." (a student)

> "I get into my own world." (a student)

The interview data indicate that both students and professionals could perceive a public performance as a positive experience if they could concentrate on the music itself in P3. For example:

> "That performance relatively went well. I did not make any significant mistakes. Well, I mean, I did not feel that I messed up the performance with obvious mistakes." (a professional pianist)

> "Well, I felt a sense of unity in the hall when my performance went well. If I feel like this, it means I am satisfied with the performance." (a professional pianist)

These results indicate that the experience of MPA symptoms is normally replaced by positive feelings when musicians go offstage. In some cases, this occurs as soon as musicians start to perform onstage, leading them to be in the "flow" state and to achieve optimal performance (Kirchner et al., 2008; Fullagar et al., 2013).

3.2. Temporal changes in coping strategies for MPA

In the questionnaire survey, the number of participants who wrote at least one comment on the mental, physical, and performance strategies for MPA was 22, 24, and 35, respectively (Table 2). Thus, student musicians employed performance strategies most frequently out of the three types of coping strategies.

A two-way ANOVA of theme × period on the number of comments (Figure 2A) revealed a significant interaction effect ($F(5.44, 201.36) = 6.40$, $p < 0.001$, partial $\eta^2 = 0.15$), in addition to a significant main effect of the theme ($F(1.75, 64.69) = 8.07$, $p = 0.001$, partial $\eta^2 = 0.18$) and of the period ($F(2.84, 105.18) = 9.77$, $p < 0.001$, partial $\eta^2 = 0.21$). The follow-up one-way ANOVAs for each of the three themes revealed a significant main effect of the period for mental strategies ($F(2.80, 103.55) = 3.85$, $p = 0.013$, partial $\eta^2 = 0.09$), physical strategies ($F(2.38, 88.08) = 9.96$, $p < 0.001$, partial $\eta^2 = 0.21$), and performance strategies ($F(2.68, 99.0) = 8.11$, $p < 0.001$, partial $\eta^2 = 0.18$), respectively. Therefore, we subsequently conducted *post hoc* Bonferroni multiple comparisons for each of the three themes to explore the origin of the main effect.

3.2.1. Mental strategies for MPA

The questionnaire data showed that the number of comments on mental strategies was relatively stable throughout the five time periods investigated, but the number of comments for P2 and P3 was slightly greater compared to that in the other periods (Figure 2B). The *post hoc* multiple comparisons for mental strategies demonstrated that the number of comments for P5 was significantly smaller than that for P2 ($p = 0.018$) and P3 ($p = 0.045$), respectively. The results indicate that mental strategies for MPA were mainly employed *shortly before* and *during* public performance. The two most popular mental strategies in P2 were positive thinking/self-talk and concentration, with nine and three participants reporting them, respectively (Table 2). Typical examples of positive thinking/self-talk in P2 were as follows:

> "I talk to myself, 'I will be alright'." (a student)

> "I believe that the piece is not too difficult and that I am well-prepared for the performance." (a student)

Six participants used the positive thinking/self-talk strategy also during the preparation for public performance (P1). For example:

> "I talk to myself, 'Since I have practiced intensely, I will be alright'." (a student)

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TABLE 2 Number of participants commenting on each theme of coping strategies in the questionnaire survey.

Theme	Sub-theme	Number (and percentage) of participants					
		P1	P2	P3	P4	P5	P1-P5
Mental strategies	Positive thinking/self-talk	6 (15.8)	9 (23.7)	4 (10.5)	2 (5.3)	1 (2.6)	**15 (39.5)**
	Concentration	1 (2.6)	3 (7.9)	6 (15.8)	3 (7.9)	0 (0.0)	**12 (31.6)**
	Avoidance behaviors	1 (2.6)	1 (2.6)	1 (2.6)	1 (2.6)	0 (0.0)	**4 (10.5)**
	Ritualized behaviors	0 (0.0)	0 (0.0)	2 (5.3)	0 (0.0)	0 (0.0)	**2 (5.3)**
	Total	**8 (21.1)**	**12 (31.6)**	**10 (26.3)**	**6 (15.8)**	**1 (2.6)**	**22 (57.9)**
Physical strategies	Breathing	0 (0.0)	8 (21.1)	5 (13.2)	1 (2.6)	0 (0.0)	**14 (36.8)**
	Sleep/rest	4 (10.5)	2 (5.3)	0 (0.0)	1 (2.6)	4 (10.5)	**7 (18.4)**
	Exercise	0 (0.0)	6 (15.8)	0 (0.0)	0 (0.0)	0 (0.0)	**6 (15.8)**
	Wiping sweat	0 (0.0)	4 (10.5)	0 (0.0)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Keeping hands/body warm	0 (0.0)	4 (10.5)	0 (0.0)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Diet	2 (5.3)	1 (2.6)	0 (0.0)	0 (0.0)	1 (2.6)	**4 (10.5)**
	General physical conditioning	0 (0.0)	1 (2.6)	0 (0.0)	0 (0.0)	1 (2.6)	**2 (5.3)**
	Massage	1 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**1 (2.6)**
	Body posture	0 (0.0)	0 (0.0)	1 (2.6)	0 (0.0)	0 (0.0)	**1 (2.6)**
	Total	**4 (10.5)**	**19 (50.0)**	**6 (15.8)**	**2 (5.3)**	**5 (13.2)**	**24 (63.2)**
Performance strategies	Content of practice	15 (39.5)	11 (28.9)	0 (0.0)	5 (13.2)	13 (34.2)	**24 (63.2)**
	Amount of practice	11 (28.9)	3 (7.9)	0 (0.0)	0 (0.0)	2 (5.3)	**15 (39.5)**
	Performing techniques	0 (0.0)	0 (0.0)	10 (26.3)	0 (0.0)	0 (0.0)	**10 (26.3)**
	Mental rehearsal	2 (5.3)	2 (5.3)	0 (0.0)	0 (0.0)	0 (0.0)	**4 (10.5)**
	Total	**26 (68.4)**	**15 (39.5)**	**10 (26.3)**	**5 (13.2)**	**15 (39.5)**	**35 (92.1)**

The values in parentheses show the percentages of participants within the present sample. The bold "Total" values indicate the numbers (and percentages) of participants commenting on at least one of the sub-themes for each theme. The bold "P1-P5" values indicate the numbers (and percentages) of participants commenting for at least one of the time periods. P1, time period 1 (from the beginning of the preparation for a public performance until the day before the performance); P2, time period 2 (from the morning of the performance day until shortly before going onstage); P3, time period 3 (during the public performance); P4, time period 4 (from shortly after going offstage until the end of the performance day); P5, time period 5 (from the next day of the performance until shortly before the next public performance).

As in these examples, the positive thinking/self-talk strategy aimed to boost self-confidence.

The two most popular strategies in P3 were again concentration and positive thinking/self-talk, with six and four participants mentioning them, respectively (Table 2). A typical example of concentration was as follows:

> "I concentrate on myself during my performance." (a student)

The results are consistent with a recent survey demonstrating that positive self-talk, as well as instructional self-talk to boost concentration on performance, were intensely used in the early stage of preparation, backstage, and onstage by student musicians (Huang and Song, 2021). In addition, two of the present participants were engaged in ritualized behaviors such as putting on a charm in P3.

Corroborating the results of the questionnaire, all eight participants of the interview reported employing the positive thinking/self-talk strategy. This strategy helped the musicians to stay positive and to believe in themselves. For example, participants tried to convince themselves by pointing to the amount of preparation they had done for a public performance. For example:

> "I talked to myself, 'I have practiced many times' to convince myself." (a student)

> "When I tried to relieve nervousness, I persuaded myself, like talking to myself, 'I have practiced many times.' I think I was using autosuggestion." (a student)

The positive thinking/self-talk strategy also included cognitive restructuring. The following dialog in the interview illustrates how professional musicians perceived making mistakes during public performance in a positive way:

> "[about making mistakes]…well, I'm a human being and [mistakes] can happen as like accidents. Audiences do not particularly expect a flawless performance." (a professional pianist)

Some students also mentioned that conversation with their parents or teachers helped them think in a more positive way. For example:

> "My mother makes me feel relieved a bit by saying 'it's not helpful to get nervous.'" (a student)

> "My teacher advised me not to worry much and to play like myself, which was memorable." (a student)

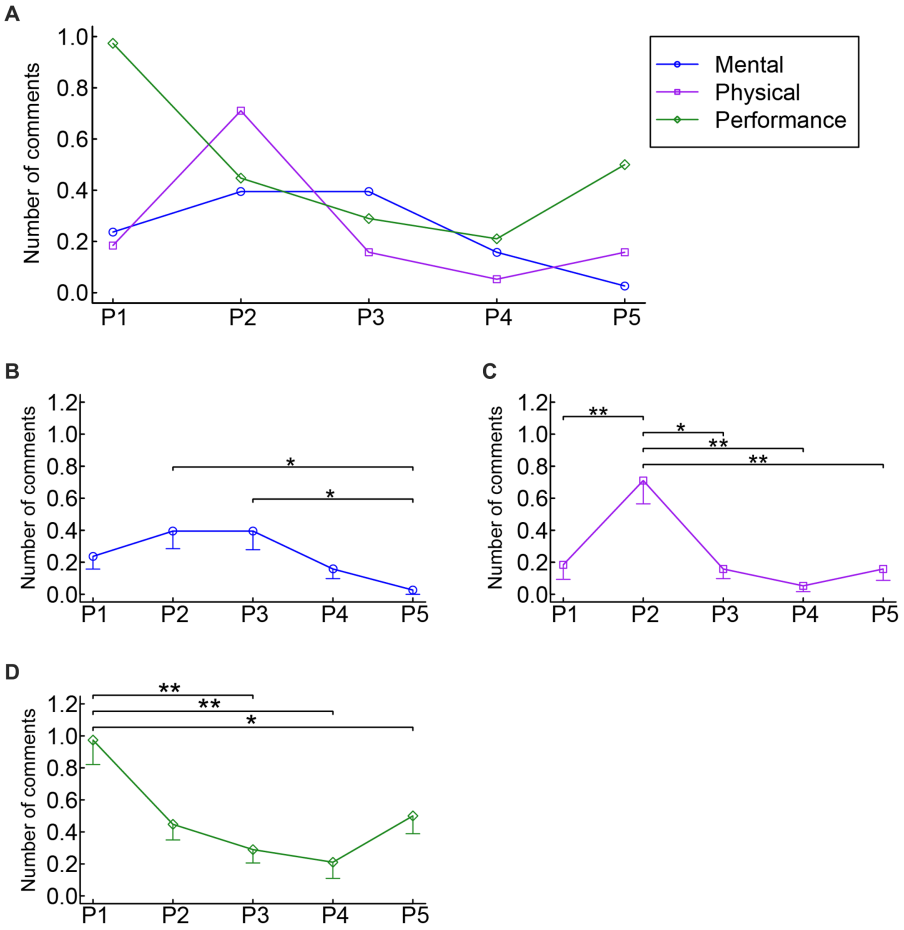

FIGURE 2
Mean number of comments for mental, physical, and performance strategies. **(A)** Summary of the results. **(B–D)** Results of the statistical analyses for mental, physical, and performance strategies, respectively. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The error bars represent standard errors of the mean. P1: time period 1 (from the beginning of the preparation for public performance until the day before the performance). P2: time period 2 (from the morning of the performance day until shortly before going onstage). P3: time period 3 (during the public performance). P4: time period 4 (from shortly after going offstage until the end of the performance day). P5: time period 5 (from the next day of the performance until shortly before the next public performance).

Previous empirical evidence suggests that positive thinking/self-talk can significantly reduce subjective anxiety and improve performance quality in musicians (Sweeney and Horan, 1982; Hoffman and Hanrahan, 2012). The present participants used the positive thinking/self-talk strategy most intensely shortly before public performance (P2), presumably to relieve negative feelings (e.g., anxiety) that were experienced most frequently in this time period (Figure 1B).

Interestingly, although student musicians employed both positive thinking and positive self-talk, professional pianists reported employing positive thinking only. Students seemed to be trying to divert their attention from undesirable thoughts and feelings effortfully by talking to themselves. In contrast, professionals tended to have positive and realistic thoughts more naturally, based on their considerable experience. For example:

> "In my view, it is self-confidence [that matters]. After I have spent plenty of time in practicing carefully, I would just rely on what I have done. I will not be more than what I have done, but I am confident that I will not be less than that either." (a professional pianist)

Furthermore, both students and professional pianists reported employing the concentration strategy as in the questionnaire. The example below indicates that concentration on performance itself can help musicians alleviate their anxiety:

> "I think that I would not get nervous if I can get into my own world." (a student)

Previous literature suggests that focusing on music performance by distracting oneself from surrounding task-irrelevant cues and/or the possibility of undesirable outcomes can reduce subjective anxiety and improve performance quality (Connolly and Williamon, 2004; Sutani and Akutsu, 2019). Therefore, the present participants employed the concentration strategy most intensely during public performance (P3), presumably to avoid the actual impairment of performance quality that was experienced in this time period (Figure 1D).

Consistent with the results of the questionnaire, some students reported being involved in ritualized behaviors in P3 to calm themselves down. For example:

> "There is a handkerchief which I always take onstage… Before a performance, I rightly wipe the keyboard with it…" (a student)

Pre-performance routines, including ritualized behaviors as in this example, can help musicians be mentally well-prepared for public performance (Ginsborg, 2004; Klickstein, 2009).

3.2.2. Physical strategies for MPA

The questionnaire data showed that the number of comments on physical strategies peaked in P2 (Figure 2C). The *post hoc* multiple comparisons for physical strategies demonstrated that the number of comments for P2 was significantly greater than that for P1 ($p = 0.008$), P3 ($p = 0.010$), P4 ($p = 0.001$), and P5 ($p = 0.005$), respectively. The results indicate that physical strategies for MPA were mainly employed *shortly before* public performance. The most popular physical strategy in P2 was breathing (e.g., deep breathing), with eight participants mentioning it (Table 2). For example:

> "I try to take a deep breath." (a student)

The breathing strategy was also employed in P3 by five participants (Table 2). These results comply with the previous finding that breathing exercises were most frequently used among different coping strategies for MPA by student musicians (Studer et al., 2011). Previous literature suggests that relaxation techniques such as deep breathing can reduce MPA by helping musicians to control physiological MPA symptoms (Su et al., 2010; Stern et al., 2012; Zhukov, 2019). Since the recognition of physiological MPA symptoms such as increased heart rate peaked in P2 (Figure 1C), musicians may have employed the breathing strategy most frequently during this time period to relieve these symptoms.

In addition, six participants reported engaging in low- or moderate-intensity exercise (e.g., stretching, jogging) in P2 (Table 2), as a pre-performance routine on the day of a public performance. For example:

> "I take light exercise such as jogging because it can help me perform well." (a student)

Previous studies show that exercise before a public performance or on a daily basis can reduce MPA by attenuating stress responses such as increased heart rate and muscle stiffness (Taylor and Wasley, 2004; Rocha et al., 2014). Participants of the present questionnaire survey may thus have attempted to relieve these symptoms reported in P2 and P3 by employing the exercise strategy. Other popular physical strategies in P2 included keeping the hands/body warm, wiping sweat, and sleep/rest, all of which would be useful for coping with other physiological MPA symptoms (i.e., cold hands/body, perspiration, and sleep disturbances).

The interview data indicates that musicians employed physical strategies most frequently in P2. Notably, all five students and two out of the three professional pianists reported that they stretched various body parts (e.g., neck, shoulders) before public performance. For example:

> "I do stretches a lot. Well, I stretched the neck, shoulders, and trunk… I was moving around a lot." (a student)

The results comply with those of the questionnaire survey, showing that both student and professional musicians were engaged in low-intensity exercise shortly before public performance to reduce muscle stiffness. As in the questionnaire, four students and two professional pianists tried to keep the hands/body warm by using hand warmers and extra clothes. For example:

> "I try to get my hands warm with hand warmers." (a student)

In addition, the breathing strategy was employed by three participants in P2 and three participants in P3, respectively. For example:

> "Recently, before a performance, I take a deep breath… pay attention to breathing. It kind of helps." (a student)

These comments by participants indicate that musicians not only breathe deeply but also attend to the depth and frequency of breathing. As in the questionnaire, participants also reported employing other physical strategies such as wiping sweat. For example:

> "I was wiping sweat on my hands with a towel when I was waiting backstage." (a student)

Compared to students, professionals seemed to be more aware of the importance of maintaining a good physical condition before public performance. In the interview, only professionals mentioned paying attention to their diet and sleep/rest in P1 and P2. For example:

> "In my case, I receive acupuncture three or four days before a performance. I then try to achieve the best physical condition on the performance day." (a professional pianist)

> "If I have something in my stomach, I feel uncomfortable… maybe because of acid reflux? So I have lunch but skip dinner before a performance." (a professional pianist)

> "Well, I do not want to get tired or sleepy in the evening [before a performance], so I definitely have a nap. I try to sleep for 30 minutes or less than one hour before leaving home, which means before arriving at the concert hall. Well, if the concert starts at 8 pm, I will surely become sleepy, so I came to have a nap before a concert in the evening, I assume." (a professional pianist)

These strategies would be helpful in preventing fatigue and gastrointestinal disturbances from negatively affecting public performance. These results are consistent with previous surveys showing that musicians were engaged in specific behaviors to improve their general physical condition (e.g., eating very little, taking a nap) before public performance (Wolfe, 1990; Roland, 1994).

3.2.3. Performance strategies for MPA

The questionnaire data showed that the number of comments on performance strategies peaked in P1, gradually decreasing toward P4

(Figure 2D). The *post hoc* multiple comparisons for performance strategies demonstrated that the number of comments for P1 was significantly greater than that for P3 ($p = 0.003$), P4 ($p = 0.002$), and P5 ($p = 0.040$), respectively. The results indicate that performance strategies for MPA were mainly employed *during the preparation* for public performance. The most popular performance strategy in P1 was the content of practice, with 15 participants mentioning it (Table 2). This complies with the previous finding that the use of practicing techniques was the most frequently used long-term coping strategy for MPA among young musicians (Fehm and Schmidt, 2006). The content of practice strategy reported in the present study primarily involved specific practicing techniques aiming at improving/maintaining playing skills (nine participants), such as playing at a slower tempo and practicing difficult parts of the piece repeatedly. For example:

> "I practice the musical piece at a slower tempo." (a student)

> "I repeatedly practice several specific phrases that are vulnerable to mistakes." (a student)

Eight participants reported practicing coping methods for any accidents or unusual situations that might arise during public performance (e.g., creating rescue plans, playing the piece in a non-ideal environment). For example:

> "I practice starting to perform from the middle of the piece just in case I stop playing during a public performance." (a student)

> "I set the room temperature a bit higher during practice, and check if I can conserve my energy till the end of the piece." (a student)

In addition, three participants mentioned that they try to improve the efficiency and effectiveness of practice in P1.

The most popular strategy in P2 was also the content of practice, with 11 participants mentioning it (Table 2). The content of practice strategy in this time period involved practicing specific phrases, having a rehearsal, double-checking the musical score, and reviewing what they had learned during practice so far. For example:

> "I repeatedly double-check the specific phrases which I feel insecure about." (a student)

The second most popular performance strategy in P1 was the amount of practice, with 11 participants mentioning it (Table 2). Most of them reported increasing the amount of practice during the preparation for public performance. For example:

> "As the performance day approaches, I spend more time in practicing the piece." (a student)

Three participants mentioned employing the amount of practice strategy also in P2. Interestingly, two of them reported that they reduce their practice hours on the performance day, presumably to avoid fatigue and to maintain an ideal physical condition (Ginsborg, 2004; Klickstein, 2009).

In addition, two participants were engaged in mental rehearsal both in P1 and P2 (Table 2). For example:

> "I mentally visualize the keyboard and the stage, and play each note in my mind." (a student)

The results are in accordance with a recent finding that student musicians utilized mental rehearsal during the preparation for public performance and when backstage (Huang and Song, 2021).

In P3, 10 participants reported employing various performing techniques, such as paying attention to the sounds and expressions (Table 2). For example:

> "I pay attention to both the melody and the bass line." (a student)

> "I perform as if I am humming the melody in my mind." (a student)

In P4 and P5, participants mainly reflected on their public performances (five and nine participants, respectively) based on their memories, the audio recording of the performance, or comments from teachers. For example:

> "I listen to the audio recording of my performance to consider what I should improve in the next public performance." (a student)

Corroborating the results of the questionnaire, interview participants employed performance strategies mainly in P1. All eight participants reported employing the content of practice strategy in P1 and P2. The strategy involved various practicing techniques aiming at improving/maintaining playing skills, such as playing at a slower tempo, practicing difficult parts of the piece repeatedly, practicing the right and left hands separately, and audio/video recording their performances. For example:

> "I practice playing slowly… really slowly to make sure of all sounds I play. My teacher told me to listen to the sounds carefully." (a student)

> "…I'm aware of [structure]…for example, a section is repeated three times and then the fourth reaches the top. I intentionally practice slower to pay attention to them. I try to understand the structure of the piece through this kind of deformation." (a professional pianist)

> "I practiced a melody with a different rhythm… and the left hand only. Yes, I practiced the left hand only a lot." (a student)

These practicing techniques are thought to be effective in gaining musical expertise in general (Klickstein, 2009), and would thus help musicians maintain performance quality even in public performance situations. Of these, playing at a slower tempo, which was mentioned most frequently by participants of the questionnaire survey, may particularly play an important role in memorizing music (Allingham and Wöllner, 2022). During practice of a musical piece, musicians' movements gradually

become automatic as the motor learning proceeds. However, when put under the stress of public performance, musicians tend to regain conscious awareness of the movements as in the early stage of motor learning, and this can cause memory slips during public performance (Ginsborg, 2004). If musicians have simulated the conscious control of movements through slow practice, taking both accuracy and expressions into account, they would be able to cope with the altered state of motor processes. Playing at a slower tempo has also been found to induce positive mental states such as mindfulness, concentration, and self-confidence (Allingham and Wöllner, 2022), all of which can contribute to optimal performance.

Reviewing each musical element, by practicing a part of the piece or the right and left hands separately, is also thought to be useful in maintaining memorization (Klickstein, 2009). Practicing difficult parts of the piece repeatedly has actually been found to be the most frequently used short-term coping strategy, and considered helpful, among young musicians (Fehm and Schmidt, 2006). Furthermore, audio/video recording a performance during practice helps musicians to objectively evaluate their performance quality and improve the efficiency of practice (Klickstein, 2009). All in all, these practicing techniques are considered to contribute to preventing MPA symptoms from impairing performance quality onstage.

In P1, three out of the five students had dress rehearsals by trying on the clothes and/or shoes that they intended to wear on the performance day. Interestingly, in the interview, only student musicians reported the need of dress rehearsal. For example:

> "Even when I practice at home before a public performance, I wear shoes for the stage performance every time." (a student)

In contrast, professional pianists felt that their outfits are not likely to be their concern. For example:

> "I did [practice with my stage outfits and shoes on] a long time ago, probably until my college days. I do not do it nowadays. I am not sensitive about this….It absolutely does not matter at all." (a professional pianist)

> "I do not wear stage outfits even during rehearsals." (a professional pianist)

All eight participants noted that opportunities to perform in public would help them boost their self-confidence in future public performances. For example, one professional pianist talked as follows:

> "When I get opportunities to play the same piece of music before an audience a couple of times in a month or so… the more I play in public, the more I feel easy. I think it reduces anxiety." (a professional pianist)

Previous literature also indicates that many musicians are engaged in physical rehearsals or dress rehearsals, often with small audiences, before public performance (Wolfe, 1990; Roland, 1994; Huang and Song, 2021). This kind of contrived performance situation can actually induce MPA symptoms, and thus provide musicians with opportunities for desensitization and context-dependent learning (Ginsborg, 2004; Klickstein, 2009). Moreover, participants of the present questionnaire survey reported practicing coping with potential accidents or unusual situations of public performance during daily practice (e.g., playing the piece in a non-ideal environment). Together, these strategies may have helped musicians to habituate themselves within specific mental and/or physical states experienced during public performance, and establish strategies to deal with these altered states.

In addition to physical practice using the instrument, participants were also engaged in mental rehearsal/practice in P1 and P2. For example, participants would imagine playing certain phrases of a piece, following each note from memory without actually playing. This kind of mental practice helped musicians to reduce their anxiety about memory slips. The following example dialog illustrates how musicians typically conducted mental rehearsal:

> "I try to play all pieces in my mind without actually playing." (a professional pianist)

As participants of both the questionnaire and the interview note, mental rehearsal involves the imaginary rehearsal of a public music performance without overt physical movements (Ginsborg, 2004; Klickstein, 2009; Huang and Song, 2021). Previous literature suggests that mental rehearsal can have various positive effects on music performance, such as improving learning and memory, achieving greater control over negative emotions, enhancing self-confidence and resilience onstage, and focusing attention on the music itself (Ginsborg, 2004). Therefore, the present participants may have attempted to cope with negative feelings, cognitive problems, and impaired motor control during public performance by using the mental rehearsal strategy.

Regarding the amount of practice, all students and professional pianists reported that more practice hours in P1 helped them feel confident. For example:

> "I could feel relieved only by the amount of time for practice." (a student)

> "It is important to practice the piece for longer. If I take time for practice, I feel like that the piece of music sticks with me." (a professional pianist)

In both the questionnaire and the interview, participants reported that they increase the amount of practice during the preparation for public performance. Previous studies indicate that more practice helps musicians to gain self-confidence and relieves MPA symptoms (Zakaria et al., 2013; Biasutti and Concina, 2014). Therefore, the present participants may also have attempted to boost self-confidence by increasing the amount of practice.

Meanwhile, previous literature suggests that longer practice time can also have adverse effects on music performance by increasing the risk of developing playing-related injuries (Passarotto et al., 2023) or by inducing fatigue before public performance (Klickstein, 2009). In the interview, professional pianists reported carefully adjusting the amount of practice toward the performance day, presumably to avoid these adverse effects. For example:

> "On the day before a public performance, I do not practice much. I spend less time practicing. I just practice as usual… I finish what I should do by two days before a public performance. Otherwise, I would get tired on the performance day." (a professional pianist)

Overall, professional pianists tended to make a more systematic plan regarding the preparation for public performance compared to students. It seemed that professionals could precisely predict potential MPA symptoms and the outcomes of their practice behaviors, based on their considerable experience. This may explain why professionals could appropriately adjust their behaviors toward a public performance. For example, a professional pianist talked as follows:

> "We have to practice anyway, so I do kind of plan backward [from a public performance], thinking of how I should practice toward the performance…" (a professional pianist)

In P3, musicians tried to pay attention to the sounds and expressions to concentrate on the performance itself. For example, one professional pianist mentioned it as follows:

> "I try to follow the melody line in my mind while performing whatever happens." (a professional pianist)

During public performance, musicians tend to experience drifts in attention, which are mainly caused by task-irrelevant thoughts, factors in the environment, recall of past experiences, and expectation of future experiences (Connolly and Williamon, 2004; Furuya et al., 2021). The present participants may have attempted to avoid drifts in attention during public performance by intentionally paying attention to specific musical aspects such as the melody and the bass line.

In P4 and P5, musicians tended to reflect on their public performances. For example:

> "After a public performance, I listen to the audio recording of the performance to reflect on how it was." (a student)

The result is in accordance with a recent finding that student musicians reflected on their mistakes made onstage after public performance (Huang and Song, 2021). It has been recommended that musicians reflect on each public performance by using resources such as the audio recording of the performance, carefully considering the causes of success or failure (Klickstein, 2009). This process would enable musicians to set an appropriate goal for their next public performance and devise better coping strategies for MPA symptoms.

4. Conclusion

This study examined how the experience of mental, physiological, and behavioral symptoms of MPA changes across different time periods around public performance and how musicians cope with the temporal changes in MPA symptoms by conducting a questionnaire survey and a semi-structured interview.

The results indicate that musicians experienced mental symptoms as soon as they began to prepare for public performance and that the experience of mental symptoms peaked shortly before public performance. The mental symptoms mainly consisted of negative feelings such as anxiety, but also included cognitive problems such as memory slips during public performance. The negative feelings seemed to have been induced primarily by the concern over mistakes and the fear of negative evaluation by others. To cope with negative feelings, musicians employed mental strategies such as positive thinking/self-talk and concentration both before and during public performance. It seemed that these mental strategies helped musicians to gain self-confidence and focused attention to music performance. Musicians also attempted to boost self-confidence by increasing the amount of practice and by utilizing both mental and physical rehearsals. To prevent memory slips during public performance, musicians adopted specialized practicing techniques such as mental practice/rehearsal and playing at a slower tempo. The experience of negative feelings was normally replaced by positive feelings such as relief and achievement when musicians went offstage, but for some musicians, this occurred as soon as they started to perform onstage.

The results further demonstrate that physiological MPA symptoms were experienced shortly before and during public performance. Similarly to mental MPA symptoms, the experience of physiological symptoms peaked shortly before public performance. Musicians experienced a variety of physiological symptoms including increased heart rate, perspiration, cold hands, and gastrointestinal disturbances. To cope with these physiological MPA symptoms, musicians effectively employed a variety of physical strategies shortly before public performance. They particularly used the breathing strategy (e.g., deep breathing) and low- or moderate-intensity exercise (e.g., stretching, jogging) in this time period, which have been found to be effective in attenuating physiological stress responses. Musicians also adopted other physical strategies such as keeping the hands/body warm, wiping sweat, and sleep/rest on the performance day to cope with cold hands/body, perspiration, and sleep disturbances, respectively. Furthermore, musicians utilized both mental and physical rehearsals to habituate themselves to the physiological symptoms experienced during public performance.

Behavioral MPA symptoms, in contrast, were experienced mostly during public performance. The most frequently mentioned symptoms were tremor and muscle stiffness, both of which can have detrimental effects on performance quality. To relieve these muscular symptoms, musicians were engaged in low- or moderate-intensity exercise such as stretching on the day of performance. During public performance, some musicians experienced the actual impairment of performance quality. In an attempt to prevent this, musicians adopted a variety of practicing techniques during the preparation for public performance, such as playing at a slower tempo and practicing difficult parts of the piece repeatedly. Musicians also tried to pay attention to specific musical aspects (e.g., sounds and expressions) to improve concentration during public performance. These practicing/performing techniques together seemed to have helped musicians to maintain performance quality onstage.

The comparison of the interview data between student and professional musicians suggest that students tended to experience the three types of MPA symptoms for a longer duration than did professionals, extending from the beginning of the preparation for a public performance until days or even weeks after the performance. Students also perceived their physiological and behavioral symptoms more negatively than did professionals, which could aggravate their anxiety. To cope with their sustained MPA

symptoms, students were more likely to rely on self-talk, dress rehearsal, ritualized behaviors, and support from parents or teachers. In contrast, professionals viewed MPA symptoms as natural and unharmful responses that accompany public performance situations. Professionals could thus form positive and realistic thoughts about public performance more naturally. Overall, professionals could precisely predict potential MPA symptoms and the outcome of their practice behaviors based on considerable experience. Based on these predictions, professionals tended to make a systematic plan regarding the preparation for public performance, appropriately adjusting their practice behaviors and physical conditions toward the performance day. These systematic strategies seemed to be a key to effectively preventing and controlling MPA symptoms. From the standpoint of music education, it would be important for educators to understand these differences between student and professional musicians and complement the limited performance experience of students. More specifically, educators should help students to make a more systematic plan to allow them adequate and appropriate preparation for public performance. Educators should also help students to form more positive and realistic thoughts about MPA symptoms. Incorporating these perspectives in music lessons and lectures would lead to more satisfying performance experiences of student musicians.

It is worth noting some limitations of this study. First, the sample size was relatively small both in the questionnaire survey and the semi-structured interview. In particular, we could not compare the data between male and female musicians due to the gender imbalance of the present sample. Since previous studies suggest that female musicians tend to experience higher MPA compared to male musicians (e.g., Hildebrandt et al., 2012; Cornett and Urhan, 2021), future work should recruit a larger sample of musicians to examine whether there are any gender differences in the coping strategies for MPA. Second, the questionnaire survey involved only undergraduate and postgraduate students majoring in music. Future work should examine whether the findings of the questionnaire survey also apply to professional musicians and novice players. Comparisons of the timeline of coping strategies for MPA between musicians with various skill levels would particularly help elucidate the effectiveness of these strategies. Third, most of the participants of the present study were pianists. Therefore, we could not compare the data of pianists with those of other instrumentalists or singers. Since previous literature suggests that MPA symptoms can vary among different types of musicians (Sokoli et al., 2022), future work should investigate how the characteristics of instruments affect coping strategies for MPA. Finally, the questionnaire survey and the interview could not objectively assess the effectiveness of different coping strategies in public performance situations. Therefore, future empirical studies should examine how each strategy influences musicians' mental and physical states and performance quality.

In summary, the present findings show that mental, physiological, and behavioral symptoms of MPA exhibit differential timelines. That is, the three types of MPA symptoms were found to be experienced by musicians in different time periods around public performance. The data indicate that musicians utilize different coping strategies according to the temporal changes in MPA symptoms. These findings will contribute to the development of more effective coping strategies and intervention methods for MPA, based on the differential timelines of the three types of symptoms. This would ultimately help young talented musicians to achieve optimal performance onstage, and improve their quality of life.

Data availability statement

The deidentified questionnaire data supporting the conclusions of this article will be made available by the corresponding author. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by National Institute of Advanced Industrial Science and Technology (AIST) Ethics Committee. The participants provided their written informed consent to participate in this study.

Author contributions

NI designed and performed the study, transcribed dialogues in the interview, and conducted preliminary analyses of the data. YM designed the study, analyzed the interview data, and wrote the manuscript. MY designed and performed the study, analyzed the questionnaire data, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Alhija, F. N. A., and Fresko, B. (2009). Student evaluation of instruction: what can be learned from students' written comments? *Stud. Educ. Eval.* 35, 37–44. doi: 10.1016/j.stueduc.2009.01.002

Allingham, E., and Wöllner, C. (2022). Putting practice under the microscope: the perceived uses and limitations of slow instrumental music practice. *Psychol. Music* doi: 10.1177/03057356221129650

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Musicae Sci.* 18, 189–202. doi: 10.1177/1029864914523282

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* 3, 77–101. doi: 10.1191/1478088706qp063oa

Brotons, M. (1994). Effects of performing conditions on music performance anxiety and performance quality. *J. Music Ther.* 31, 63–81. doi: 10.1093/jmt/31.1.63

Burin, A. B., and Osório, F. L. (2017). Music performance anxiety: a critical review of etiological aspects, perceived causes, coping strategies and treatment. *Arch. Clin. Psychiatry (São Paulo)* 44, 127–133. doi: 10.1590/0101-60830000000136

Connolly, C., and Williamon, A. (2004). "Mental skills training" in *Musical Excellence: Strategies and Techniques to Enhance Performance*. ed. A. Williamon (Oxford: Oxford University Press), 221–246.

Cornett, V., and Urhan, G. (2021). Performance anxiety experiences and coping techniques of Turkish music students and their teachers. *Int. J. Music Educ.* 39, 504–519. doi: 10.1177/02557614211005907

Critchley, H. D. (2005). Neural mechanisms of autonomic, affective, and cognitive integration. *J. Comp. Neurol.* 493, 154–166. doi: 10.1002/cne.20749

Dejonckheere, M., and Vaughn, L. M. (2019). Semistructured interviewing in primary care research: a balance of relationship and rigour. *Fam. Med. Community Health* 7:e000057. doi: 10.1136/fmch-2018-000057

Drake, C., and Palmer, C. (2000). Skill acquisition in music performance: relations between planning and temporal control. *Cognition* 74, 1–32. doi: 10.1016/S0010-0277(99)00061-X

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disord.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/s0033291719001910

Fishbein, M., Middlestadt, S. E., Ottati, V., Straus, S., and Ellis, A. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Probl. Perform. Art.* 3, 1–8.

Franzosi, R. P. (2004). "Content analysis" in *Handbook of Data Analysis*. eds. M. Hardy and A. Bryman (London: Sage Publications), 547–566.

Fredrikson, M., and Gunnarsson, R. (1992). Psychobiology of stage fright: the effect of public performance on neuroendocrine, cardiovascular and subjective reactions. *Biol. Psychol.* 33, 51–61. doi: 10.1016/0301-0511(92)90005-F

Fullagar, C. J., Knight, P. A., and Sovern, H. S. (2013). Challenge/skill balance, flow, and performance anxiety. *Appl. Psychol.* 62, 236–259. doi: 10.1111/j.1464-0597.2012.00494.x

Furuya, S., Ishimaru, R., and Nagata, N. (2021). Factors of choking under pressure in musicians. *PLoS One* 16:e0244082. doi: 10.1371/journal.pone.0244082

Gannon, P. (2019). Is it anxiety or arousal that can facilitate musical performance? *Med. Probl. Perform. Art.* 34, 118–119. doi: 10.21091/mppa.2019.2018

Ginsborg, J. (2004). "Strategies for memorizing music" in *Musical Excellence: Strategies and Techniques to Enhance Performance*. ed. A. Williamon (Oxford: Oxford University Press), 123–142.

Guyon, A. J. A. A., Hildebrandt, H., Güsewell, A., Horsch, A., Nater, U. M., and Gomez, P. (2022). How audience and general music performance anxiety affect classical music students' flow experience: a close look at its dimensions. *Front. Psychol.* 13:959190. doi: 10.3389/fpsyg.2022.959190

Hamann, D. L., and Sobaje, M. (1983). Anxiety and the college musician: a study of performance conditions and subject variables. *Psychol. Music* 11, 37–50. doi: 10.1177/0305735683111005

Hildebrandt, H., Nübling, M., and Candia, V. (2012). Increment of fatigue, depression, and stage fright during the first year of high-level education in music students. *Med. Probl. Perform. Art.* 27, 43–48. doi: 10.21091/mppa.2012.1008

Hoffman, S. L., and Hanrahan, S. J. (2012). Mental skills for musicians: managing music performance anxiety and enhancing performance. *Sport Exerc. Perform. Psychol.* 1, 17–28. doi: 10.1037/a0025409

Huang, W. L., and Song, B. (2021). How do college musicians self-manage musical performance anxiety: strategies through time periods and types of performance. *Int. J. Music Educ.* 39, 95–118. doi: 10.1177/0255761421990800

Kaspersen, M., and Gotestam, K. G. (2002). A survey of music performance anxiety among Norwegian music students. *Eur. J. Psychiatry* 16, 69–80.

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Disord.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kirchner, J. M., Bloom, A. J., and Skutnick-Henley, P. (2008). The relationship between performance anxiety and flow. *Med. Probl. Perform. Art.* 23, 59–65. doi: 10.21091/mppa.2008.2012

Klickstein, G. (2009). *The Musician's Way: A Guide to Practice, Performance, and Wellness*. New York: Oxford University Press.

Kobori, O., Yoshie, M., Kudo, K., and Ohtsuki, T. (2011). Traits and cognitions of perfectionism and their relation with coping style, effort, achievement, and performance anxiety in Japanese musicians. *J. Anxiety Disord.* 25, 674–679. doi: 10.1016/j.janxdis.2011.03.001

Kotani, S., and Furuya, S. (2018). State anxiety disorganizes finger movements during musical performance. *J. Neurophysiol.* 120, 439–451. doi: 10.1152/jn.00813.2017

Maisonneuve, J. J., Lambert, T. W., and Goldacre, M. J. (2014). Doctors' views about training and future careers expressed one year after graduation by UK-trained doctors: questionnaire surveys undertaken in 2009 and 2010. *BMC Med. Educ.* 14:270. doi: 10.1186/s12909-014-0270-5

McIntosh, M. J., and Morse, J. M. (2015). Situating and constructing diversity in semi-structured interviews. *Glob. Qual. Nurs. Res.* 2:2333393615597674. doi: 10.1177/2333393615597674

Orejudo Hernández, S., Zarza-Alzugaray, F. J., and Casanova, O. (2018). Music performance anxiety: substance use and career abandonment in Spanish music students. *Int. J. Music Educ.* 36, 460–472. doi: 10.1177/0255761418763903

Osborne, M. S., and Franklin, J. (2002). Cognitive processes in music performance anxiety. *Aust. J. Psychol.* 54, 86–93. doi: 10.1080/00049530210001706543

Osborne, M. S., and Kenny, D. T. (2005). Development and validation of a music performance anxiety inventory for gifted adolescent musicians. *J. Anxiety Disord.* 19, 725–751. doi: 10.1016/j.janxdis.2004.09.002

Paliaukiene, V., Kazlauskas, E., Eimontas, J., and Skeryte-Kazlauskiene, M. (2018). Music performance anxiety among students of the academy in Lithuania. *Music Educ. Res.* 20, 390–397. doi: 10.1080/14613808.2018.1445208

Papageorgi, I., Creech, A., and Welch, G. (2013). Perceived performance anxiety in advanced musicians specializing in different musical genres. *Psychol. Music* 41, 18–41. doi: 10.1177/0305735611408995

Passarotto, E., Worschech, F., and Altenmüller, E. (2023). The effects of anxiety on practice behaviors and performance quality in expert pianists. *Front. Psychol.* 14:1152900. doi: 10.3389/fpsyg.2023.1152900

Rocha, S. F., Marocolo, M., Corrêa, E. N. V., Morato, G. S. G., and da Mota, G. R. (2014). Physical activity helps to control music performance anxiety. *Med. Probl. Perform. Art.* 29, 111–112. doi: 10.21091/mppa.2014.2022

Roland, D. (1994). How professional performers manage performance anxiety. *Res. Stud. Music Educ.* 2, 25–35. doi: 10.1177/1321103X9400200105

Salmon, P. G. (1990). A psychological perspective on musical performance anxiety: a review of the literature. *Med. Probl. Perform. Art.* 5, 2–11.

Sickert, C., Klein, J. P., Altenmüller, E., and Scholz, D. S. (2022). Low self-esteem and music performance anxiety can predict depression in musicians. *Med. Probl. Perform. Art.* 37, 213–220. doi: 10.21091/mppa.2022.4031

Sokoli, E., Hildebrandt, H., and Gomez, P. (2022). Classical music students' pre-performance anxiety, catastrophizing, and bodily complaints vary by age, gender, and instrument and predict self-rated performance quality. *Front. Psychol.* 13:905680. doi: 10.3389/fpsyg.2022.905680

Steptoe, A. (2001). "Negative emotions in music making: the problem of performance anxiety" in *Music and Emotion*. eds. P. N. Juslin and J. A. Sloboda (Oxford: Oxford University Press), 291–307.

Steptoe, A., and Fidler, H. (1987). Stage fright in orchestral musicians: a study of cognitive and behavioural strategies in performance anxiety. *Br. J. Psychol.* 78, 241–249. doi: 10.1111/j.2044-8295.1987.tb02243.x

Stern, J. R. S., Khalsa, S. B. S., and Hofmann, S. G. (2012). A yoga intervention for music performance anxiety in conservatory students. *Med. Probl. Perform. Art.* 27, 123–128. doi: 10.21091/mppa.2012.3023

Stoeber, J., and Eismann, U. (2007). Perfectionism in young musicians: relations with motivation, effort, achievement, and distress. *Pers. Individ. Differ.* 43, 2182–2192. doi: 10.1016/j.paid.2007.06.036

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Su, Y. H., Luh, J. J., Chen, H. I., Lin, C. C., Liao, M. J., and Chen, H. S. (2010). Effects of using relaxation breathing training to reduce music performance anxiety in 3rd to 6th graders. *Med. Probl. Perform. Art.* 25, 82–86. doi: 10.21091/mppa.2010.2016

Sutani, S., and Akutsu, T. (2019). The life history of performance anxiety in Japanese professional orchestral players: a case series. *Med. Probl. Perform. Art.* 34, 63–71. doi: 10.21091/mppa.2019.2009

Sweeney, G. A., and Horan, J. J. (1982). Separate and combined effects of cue-controlled relaxation and cognitive restructuring in the treatment of musical performance anxiety. *J. Couns. Psychol.* 29, 486–497. doi: 10.1037/0022-0167.29.5.486

Taylor, A. H., and Wasley, D. (2004). "Physical fitness" in *Musical Excellence: Strategies and Techniques to Enhance Performance*. ed. A. Williamon (Oxford: Oxford University Press), 163–178.

van Kemenade, J. F., van Son, M. J., and van Heesch, N. C. (1995). Performance anxiety among professional musicians in symphonic orchestras: a self-report study. *Psychol. Rep.* 77, 555–562. doi: 10.2466/pr0.1995.77.2.555

Wesner, R. B., Noyes, R., and Davis, T. L. (1990). The occurrence of performance anxiety among musicians. *J. Affect. Disord.* 18, 177–185. doi: 10.1016/0165-0327(90)90034-6

Wolfe, M. L. (1989). Correlates of adaptive and maladaptive musical performance anxiety. *Med. Probl. Perform. Art.* 4, 49–56.

Wolfe, M. L. (1990). Relationships between dimensions of musical performance anxiety and behavioral coping strategies. *Med. Probl. Perform. Art.* 5, 139–144.

Yoshie, M., Kanazawa, E., Kudo, K., Ohtsuki, T., and Nakazawa, K. (2011). "Music performance anxiety and occupational stress among classical musicians" in *Handbook of Stress in the Occupations*. eds. J. Langan-Fox and C. Cooper (Cheltenham: Edward Elgar Publishing), 409–425.

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009a). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Yoshie, M., Kudo, K., and Ohtsuki, T. (2008a). Effects of psychological stress on state anxiety, electromyographic activity, and arpeggio performance in pianists. *Med. Probl. Perform. Art.* 23, 120–132. doi: 10.21091/mppa.2008.3024

Yoshie, M., Kudo, K., and Ohtsuki, T. (2009b). Motor/autonomic stress responses in a competitive piano performance. *Ann. N. Y. Acad. Sci.* 1169, 368–371. doi: 10.1111/j.1749-6632.2009.04786.x

Yoshie, M., and Shigemasu, K. (2007). Effects of trait social anxiety and cognitions of perfectionism on state music performance anxiety. *Jpn. J. Pers.* 15, 335–346. doi: 10.2132/personality.15.335

Yoshie, M., Shigemasu, K., Kudo, K., and Ohtsuki, T. (2008b). "Multidimensional anxiety and music performance: an exploratory application of the zones of optimal functioning model" in *Stress and Anxiety: Application to Life Span Development and Health Promotion*. eds. M. Eysenck, P. Buchwald and T. Ringeisen (Berlin: Logos Verlag Berlin), 163–171.

Yoshie, M., Shigemasu, K., Kudo, K., and Ohtsuki, T. (2009c). Effects of state anxiety on music performance: relationship between the revised competitive state anxiety Inventory-2 subscales and piano performance. *Musicae Sci.* 13, 55–84. doi: 10.1177/1029864909013001003

Zakaria, J. B., Musib, H. B., and Shariff, S. M. (2013). Overcoming performance anxiety among music undergraduates. *Procedia. Soc. Behav. Sci.* 90, 226–234. doi: 10.1016/j.sbspro.2013.07.086

Zarza-Alzugaray, F. J., Orejudo, S., Casanova, O., and Aparicio-Moreno, L. (2018). Music performance anxiety in adolescence and early adulthood: its relation with the age of onset in musical training. *Psychol. Music* 46, 18–32. doi: 10.1177/0305735617691592

Zhukov, K. (2019). Current approaches for management of music performance anxiety: an introductory overview. *Med. Probl. Perform. Art.* 34, 53–60. doi: 10.21091/mppa.2019.1008

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Music performance anxiety: the role of early parenting experiences and cognitive schemas

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Music Performance Anxiety (MPA) is a common challenge for classical musicians, however its etiology has received minimal research, particularly in regards to caregiver experiences during childhood and adolescence. The aim of this research was to explore the impact of childhood experiences with parents along with patterns of dysfunctional cognitive schemas that develop through childhood ('Early Maladaptive Schemas'; EMSs) on the manifestation and severity of MPA in adulthood. Study 1 employed 100 adult professional, amateur, and tertiary student classical musicians from across Australia. Participants completed the Young Schema Questionnaire (YSQ) and the Kenny Music Performance Anxiety Inventory (K-MPAI). Study 2 included eight participants from Study 1, five of whom scored 1.5 standard deviations or more above the mean K-MPAI score and three of whom scored 1.5 standard deviations or more below the mean K-MPAI score. Participants were interviewed about experiences of parenting during childhood and adolescence, along with their experiences of MPA and musical training. Interpretative phenomenological analysis was used to explore themes in the interview data. Study 1 factor analysis revealed four higher-order EMS factors, $F_{(4,95)} = 13.74$, $p < 0.001$, one of which was a significant predictor of MPA, $t_{(99)} = 3.06$, $p = 0.003$. This factor comprised themes of failure, catastrophising, and incompetence/dependence. Study 2 qualitative analysis revealed various key parenting themes experienced in childhood that differentiated low- and high-MPA scorers in adulthood. Findings from both studies are discussed in light of clinical applications and interventions, and implications for both parents and music educators.

KEYWORDS

music performance anxiety (MPA), Early Maladaptive Schemas (EMS), parenting styles, teaching, treatment

1. Introduction

Research into the phenomenology of music performance anxiety (MPA) has received significant empirical attention, though to-date it has predominantly focused on factors such as symptomatology, demographic and contextual factors, and comorbid psychopathology (Wesner et al., 1990; Cox and Kenardy, 1993; Brotons, 1994; Mor et al., 1995; Huston, 2001; Osborne and Franklin, 2002; Kenny et al., 2004; Smith and Rickard, 2004; Osborne and Kenny, 2005; Iusca and Dafinoiu, 2012; Patston and Osborne, 2016). Despite the dearth of literature exploring the developmental underpinnings of MPA, evidence of the detrimental impact of overcontrolling, overinvolved parenting in young musicians' autonomy, feelings of

competence, intrinsic motivation, engagement in music, and general self-efficacy (McPherson et al., 2012; Givertz and Segrin, 2014) suggests that parenting experiences in childhood may have an important role in mitigating or exacerbating the development of MPA. Thus, in this paper we examine the impact of childhood caregiver experiences and the development of maladaptive cognitive frameworks on the emergence of MPA in adult musicians. Study 1 investigated the relationship between Early Maladaptive Schemas (EMSs) and MPA through a quantitative study of adult classical musicians. Study 2 then extended findings from Study 1 through semi-structured interviews of a sub-set of musicians from the Study 1 sample, enabling in-depth investigation into individuals' experiences with primary carers throughout childhood and adolescence.

In order to provide a robust theoretical framework for a developmental investigation of MPA, Barlow's (2000) model of the aetiology and phenomenology of clinical anxiety disorders was adopted (see, Kenny and Osborne, 2006; Kenny, 2011; Osborne, 2015). Barlow outlines three vulnerabilities that can account for development of anxiety or mood disorders: a *generalized biological vulnerability* (or heritability), a *generalized psychological vulnerability* (based on early experiences of developing a sense of control over salient events), and a *more specific psychological vulnerability* (in which an individual learns to focus their anxiety on specific objects or situations). Barlow's model therefore acknowledges the interplay between biological predisposition, early social experiences, and learned response patterns to repeated life experiences that induce anxiety (such as past anxiety-inducing performing experiences). In relation to MPA, Barlow's model provides a foundation to explore the impact of early social learning experiences on the development, experience, and perpetuation of MPA in adult musicians. In the context of MPA research, two prongs of Barlow's model are illustrated by Osborne and Kenny (2008), who found that trait anxiety and gender (*generalized biological vulnerability*) predicted MPA in adolescents, and that this prediction was strengthened by the presence of negative appraisals by young musicians in relation to their perceived "worst" performance experiences (*specific psychological vulnerability*).

This paper outlines two studies that explored the role of early interpersonal experiences with primary caregivers in the development of MPA, and examined how the development of MPA may be shaped by an individual's developing self-concept, beliefs, and perceptions of the social world through their formative years. In order to address the shortfall in research exploring early parenting experiences in the development of MPA, we applied Young et al. (2003) Early Maladaptive Schema model (Young et al., 2003) as a lens through which to explore the *generalized psychological vulnerability* that may precipitate MPA in classically-trained musicians. The research comprised both quantitative and qualitative studies, and investigated the impact of early experiences with primary carers on the development of cognitive schemas (or cognitive organizing frameworks) that are relevant to a musician's perception of their social world and their sense of self. Through this research, we hoped to illuminate core social and emotional processing schemas that might predispose the development of MPA.

Young's Early Maladaptive Schema model (Young et al., 2003) was originally conceptualized to explore the development of interpersonal schemas in early childhood that affect the emergence of complex personality issues and personality disorders in adulthood. The Early Maladaptive Schemas (EMSs) described by Young are closely modeled on Aaron Beck's formulation of cognitive schemas; however, they represent a specific maladaptive or self-defeating subset of the schema concept (Young et al., 2003). For example, whilst healthy, adaptive interpersonal schemas may develop in an individual who has experienced a childhood characterized by secure, healthy attachment and support by primary carers, individuals who have experienced abusive, neglectful, or hypercritical parenting may be more likely to develop maladaptive interpersonal schemas and social expectations that others will mistreat or harm them in some way. As such, Young et al. (2003) defined EMSs as:

> Broad pervasive themes or patterns [comprising] memories, emotions, cognitions, and bodily sensations, [relating to] oneself and one's relationship with others, [developing] during childhood or adolescence, [that are] elaborated throughout one's lifetime, and [are] dysfunctional to a significant degree (p. 7).

EMSs therefore serve as templates for the processing of later experiences (Young, 1999). They are triggered by everyday events that are related to the schema's content (e.g., themes around perceived incompetence, shame, fears of criticism or harm), and they are central to an individual's self-concept; particularly self-concept relating to interpersonal context (Young et al., 2003; van Genderen et al., 2012). Individuals may not have awareness of their EMS patterns or the impact of early experiences, and EMSs are likely to be deeply entrenched and automated, particularly in more severe cases. As such, they are difficult to shift, as they become the foundation for self-concepts, personality, and social processing through early social modeling and repeated use (Young, 1999).

EMSs do not always develop as the consequence of early trauma; rather, Young et al. (2003) refers to *dysfunctional* childhood experiences. For example, an individual may develop an EMS relating to perceived incompetence and dependence, which may develop in the context of parental overprotection or over-sheltering during childhood, leading to destructive beliefs around lack of self-efficacy and autonomy as the child matures.

Conversely, Young et al. (2003) describe a range of *core emotional needs* that children require for healthy psychological development. These include: (1) Secure attachments to others (which incorporate safety, stability, nurturance, and acceptance); (2) Autonomy, competence, and a sense of identity; (3) Freedom for the child to express valid needs and emotions; (4) Spontaneity and play; and (5) Realistic limits and self-control. Young et al. (2003) highlight that biological temperament impacts on a child's resilience and response to early caregiver environments; however, according to Young et al. (2003) model, EMSs may develop if core emotional needs are not met in childhood.

Eighteen EMSs have been identified by Young et al. (2003), which may vary depending on the child's temperament and childhood experiences. Young et al. (2003) also outline five theoretically-grounded schema "domains" in which these 18

EMSs are grouped, and each domain corresponds with a specific core emotional need. The 18 EMSs five schema domains, and corresponding core emotional needs are outlined in Table 1.

Whilst Young et al. (2003) concept of core emotional needs and their role in EMS development has not been empirically validated, there are numerous studies exploring the relationship between early childhood family environments and the role of EMSs as a mediating factor in the development of anxiety and depression. For example, EMSs relating to themes of worthlessness and loss (*Emotional Deprivation*, *Dependence/Incompetence*, *Defectiveness/Shame*, *Failure to Achieve*, and *Social Isolation*) were found to mediate the relationship between childhood adversity and anhedonic symptoms in adolescents (Lumley and Harkness, 2007). The same authors reported that EMSs relating to themes of danger (*Mistrust/Abuse* and *Vulnerability to Harm or Illness*) mediated the relationship between childhood adversity and anxious symptoms. Similar results have been found for the mediating role of various EMSs (*Dependence/Incompetence, Emotional Inhibition, Failure to Achieve,* and *Vulnerability to Harm or Illness*) in the relationship between poor parenting in childhood (low care and high overprotection) and the development of depression in adulthood (Shah and Waller, 2000). Thus, these studies indicate that dysfunctional parenting styles can be important risk factors in the development of adult anxiety and depression, and arguably for the development of adult MPA. Furthermore, as EMSs have been identified as mediating factors, they may play a role in understanding *how* these experiences of parenting styles during childhood may impact on the experience of MPA in adulthood.

The conceptualization of "performance anxiety" can be considered more broadly as a subtype of Social Phobia, referenced within the Diagnostic and Statistical Manual of Mental Disorders (5th ed., text rev.) (DSM-5-TR; APA, 2022) by stipulating a "performance only" specifier subtype of Social Phobia (Social Anxiety Disorder) associated with 'speaking or performing in public' that includes "fears that are typically most impairing in [the individual's] professional lives (e.g., musicians…)" (Social Anxiety Disorder, Specifiers). This conceptualization is widely supported in literature investigating MPA (Eng et al., 2000; Furmark et al., 2000; Barlow, 2002; Osborne and Franklin, 2002; Osborne and Kenny, 2005; Kenny, 2011). Relationships between Social Phobia more broadly and EMSs have also been identified in prior research (Pinto-Gouveia et al., 2006; Gonzalez Diez et al., 2012), pointing to a similar relationship between EMSs and the presence of MPA, if MPA is understood as a subtype of Social Phobia.

Several studies have also explored relationships between early childhood caregiver experiences and the development of Social Phobia. For example, parental criticism, parental shaming, parental overprotection, and social isolation in childhood, have all been identified as potential contributors to the development of Social Phobia in interaction with the child's temperament (Hudson and Rapee, 2000; Neal and Edelmann, 2003). Similarly, a relationship has been identified between Social Phobia and childhood experiences of parental rejection, overprotection, and lack of emotional warmth (Arrindell et al., 1983). Outpatients with Social Phobia also report significantly elevated experiences of parental overprotection and significantly depleted parental care (i.e., emotional warmth, empathy, and affection) when compared to non-clinical controls (Parker, 1979; Parker et al., 1979; Rapee, 1997; Rapee and Melville, 1997).

These studies indicate that the quality of childhood attachment and early social experiences may be important in the development of Social Phobia, and therefore point to the importance of investigating the role of early experiences in the development of MPA. The identified relationships between EMSs and Social Phobia also suggest that Young's EMS framework may be valuable for conceptualizing the etiology and phenomenology of MPA, and may provide clinicians with a comprehensive yet concise framework for approaching individual factors underlying a client's presenting difficulties (Osborne and Kirsner, 2022).

The aims and hypotheses for this research extended across two studies. In Study 1, we aimed to determine whether a relationship exists between EMSs and MPA, and if so, whether particular patterns of EMSs predict MPA in adults. Findings from Study 1 were subsequently examined in Study 2 through in-depth interviews with a subset of musicians from study 1, with the aim of exploring specific early experiences with primary caregivers, and comparing those with severe MPA in adulthood to those with minimal experiences of MPA.

In Study 1, we hypothesized that a global EMS score (a total score of all 18 EMS scores combined) would demonstrate a significant positive association with MPA scores. Given that previous research has identified a broad range of EMSs associated with relevant constructs such as Social Phobia and anxiety more generally, further exploration of specific groups of EMSs that may serve EMSs as predictors of MPA was exploratory in nature.

In Study 2 we hypothesized that particular aversive experiences of parenting during childhood (such as overcontrolling or neglectful parenting experiences) would be more likely to be reported in adults who experienced high levels of MPA.

2. Study 1: the relationship between Early Maladaptive Schemas and MPA

2.1. Method

2.1.1. Participants

Participants ($n = 100$) were recruited via social media, email, and advertisements placed within The University of Melbourne, and were required to be 18 years and over, classically-trained, and have five or more years of experience on their instrument. The sample comprised 25 males, 74 females, and one participant who preferred not to provide gender information. The age range of participants varied from 18 to 24 years (13%) through to 65 years or older (1%). A majority of participants were in the 25–34 years (29%) and 35–44 years (30%) age groups, with 17% of participants in the 45–54 years and 10% in the 55–65 years age groups. The sample contained a mixture of full-time (25%) and part-time (24%) professional performers, undergraduate and postgraduate students (14%), amateur musicians (32%), and five participants who had ceased playing due to their MPA (5%). Principal instruments were varied, but were biased toward string players, with 60% of the sample playing a stringed instrument, and the remainder being spread across woodwind (17%), keyboard (8%), brass (4%), percussion (2%), and voice (9%).

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TABLE 1 Young's early maladaptive schemas.

Schema domain	EMSS	Core emotional need
Disconnection and rejection		
Expectation that one's needs for security, safety, stability, nurturance, empathy, sharing of feelings, acceptance, and respect will not be met in a predictable manner. Typical family origin is detached, cold, rejecting, withholding, lonely, explosive, unpredictable, or abusive.	1. Abandonment/instability 2. Mistrust/abuse 3. Emotional deprivation 4. Defectiveness/shame 5. Social isolation/alienation	Secure attachments to others
Impaired autonomy and performance		
Expectations about oneself and the environment that interfere with one's perceived ability to separate, survive, function independently, or perform successfully. Typical family origin is enmeshed, undermining of child's confidence, overprotective, or failing to reinforce child for performing competently outside the family.	1. Dependence/incompetence 2. Vulnerability to harm or illness 3. Enmeshment/underdeveloped self 4. Failure to achieve	Autonomy, competence, and a sense of identity
Impaired limits		
A deficiency in internal limits, responsibility to others, or long-term goal-orientation. Leads to difficulty respecting the rights of others, cooperating with others, making commitments, or setting and meeting realistic personal goals. Typical family origin is characterized by permissiveness, overindulgence, lack of direction, or a sense of superiority – rather than appropriate confrontation, discipline, and limits in relation to taking responsibility, cooperating in a reciprocal manner, and setting goals. In some cases, child may not have been pushed to tolerate normal levels of discomfort, or may not have been given adequate supervision, direction, or guidance.	1. Entitlement/grandiosity 2. Insufficient self-control/self-discipline	Freedom for the child to express valid emotions
Other-directedness		
An excessive focus on the desires, feelings, and responses of others, at the expense of one's own needs, in order to gain love and approval, maintain one's sense of connection, or avoid retaliation. Usually involves suppression and lack of awareness regarding one's own anger and natural inclinations. Typical family origin is based on conditional acceptance: children must suppress important aspects of themselves in order to gain love, attention, and approval. In many such families, the parents' emotional needs and desires – or social acceptance and status – are valued more than the unique needs and feelings of each child.	1. Subjugation 2. Self-Sacrifice 3. Approval-Seeking/Recognition/Seeking	Spontaneity and play
Overvigilance and inhibition		
An excessive emphasis on suppressing one's spontaneous feelings, impulses, and choices *or* on meeting rigid, internalized rules and expectations about performance and ethical behavior - often at the expense of happiness, self-expression, relaxation, close relationships, or health. Typical family origin is grim, demanding, and sometimes punitive: performance, duty, perfectionism, following rules, hiding emotions, and avoiding mistakes predominate over pleasure, joy, and relaxation. There is usually an undercurrent of pessimism and worry—that things could fall apart if one fails to be vigilant and careful at all times.	1. Negativity/pessimism 2. Emotional inhibition 3. Unrelenting standards/hypercriticalness punitiveness	Realistic limits and self-control

2.1.2. Measures

Background information was obtained through a series of questions assessing age, gender, role of music in life (professional, amateur), primary musical instrument, years of experience on instrument, experience of treatment, and use of beta blockers.

MPA was measured using the Kenny Music Performance Anxiety Inventory (*K-MPAI*; Kenny, 2011). This is a 40-item self-report scale that was developed to assess the existence and severity of symptoms associated with MPA on a 7-point Likert scale, ranging from "0 = Strongly disagree", to "6 = Strongly agree". Consistent with the measure's theoretical underpinnings in Barlow's tripartite theory of the development of anxiety disorders, principal axis factoring yields three focal areas comprising (1) early relationships and attachment (e.g., "One or both of my parents were overly anxious", "My parents were mostly responsive to my needs"), (2) general underlying psychological vulnerability (e.g., "From early on in my music studies, I remember being anxious about performing", "Sometimes I feel anxious for no particular reason"), and (3) performance concern factors (e.g., "Prior to or during a performance, I get feelings akin to panic", "Thinking about the evaluation I may get interferes with my performance") (Kenny, 2011). The inventory demonstrates excellent internal reliability in Australian musicians with Cronbach's alpha ranging from 0.86 to 0.95 for one high order and two first-order factors, and equaling 0.94 for the whole scale (Chang-Arana et al., 2017). This indicates appropriate assessment of MPA as a unidimensional construct. Construct validity has been established with Australian professional musicians with highly significant correlations ranging between 0.40 and 0.71 with the State-Trait Anxiety Inventory (Trait), the Social Phobia Inventory, the Anxiety and Depression Detector, and $r = -0.53$ with Core Self-Evaluations (measuring self-esteem and self-efficacy). A cut-off score of 105 on the measure was indicated for clinically significant levels of distress (see Kenny et al., 2014).

EMSs were measured by the Young Schema Questionnaire – Short Form (*YSQ-S3*; Young, 2005), which assesses all 18 EMSs identified by Young et al. (2003). The scale contains 90 items rated on a 6-point Likert scale, ranging from "1 = Completely untrue of me", to "6 = Describes me perfectly", with five individual items relating to each individual EMS. Wording was minimally changed for the questionnaire instructions to improve emotional sensitivity for those who may have experienced parental death or parental estrangement (i.e., items that referred to current relationships with parents were adapted to overcome this assumption).

Strong internal consistency (Cronbach's alpha of 0.96 for the overall scale) was demonstrated for the previous 75-item version of the YSQ-S3 (measuring 15 rather than 18 EMSs) in an Australian undergraduate sample (Baranoff et al., 2006). Several non-English translated versions of the current 90-item YSQ-S3 have demonstrated adequate validity and internal consistency for all of the 18 schemas (Saariaho et al., 2009; Hawke and Provencher, 2012; Kriston et al., 2013), with Cronbach's alpha coefficients ranging from 0.66 to 0.94 for individual EMSs across the studies. Psychometric support for the translated versions of the YSQ-S3 mirrors that reported for the English versions of the full-length scale and previous versions of the short-form scale (Steptoe and Fidler, 1987; Welburn et al., 2002).

2.1.3. Procedure

Participants were provided with the link for the online survey on SurveyMonkey©, which included a copy of the plain language statement and consent form, the latter of which participants were required to provide by ticking a box indicating their consent. They were first presented with background questions, followed by the K-MPAI and the YSQ-S3. A debriefing statement concluded the online survey. The survey was formatted such that participants were unable to progress through the survey unless all questions were completed. Participants were free to withdraw from the study at any point during their participation. The study was given approval by The University of Melbourne Human Research Ethics Committee.

The statistical procedure was as follows: Means and standard deviations were generated to inspect for outliers and skewness, and Box-Cox transformations (Osborne, 2010) were applied to all variables to account for abnormal distribution of some variables. Correlational analyses were conducted between independent and dependent variables. Exploratory factor analyses were performed to identify broader themes (factors) within the YSQ-S3 items. Multiple regression analyses were then performed to investigate the relationship between each of the YSQ-S3 factors and the overall K-MPAI scores.

2.2. Results

Descriptive data are presented in Table 2. Due to skewness in the data for a majority of the EMS scores, Box Cox transformations were carried out on all 18 EMSs to ensure that the data adhered to assumptions of normality for parametric analyses (Osborne, 2010). No significant differences were found in K-MPAI scores for any of the background variables (gender, age, instrument, role of music), and thus all subsequent data analyses were performed on the whole sample.

Cronbach's alpha coefficients were calculated for the K-MPAI (alpha = 0.85) and for all YSQ-S3 EMSs (coefficients ranged from 0.71 for *Self-Sacrifice* and *Unrelenting Standards/Hypercriticalness* to 0.93 for *Defectiveness/Shame*). As all alpha coefficients were above the cut-off point of 0.70 (Field, 2009), both scales were considered to have acceptable internal consistency for the current sample and are in line with previous psychometric investigations of each measure (Saariaho et al., 2009; Kriston et al., 2013; Chang-Arana et al., 2017).

Scores for the K-MPAI in the current study ranged from 61 to 186. Interestingly, the mean K-MPAI score (M = 122.53, SD = 27.34) was significantly higher than in a previously published sample of tertiary flute players (M = 68, SD = 18.97; $t_{(118)} = 8.51$, $p < 0.001$; Kenny et al., 2011), and professional orchestral musicians (M = 83.73, SD = 40.72; $t_{(471)} = 9.00$, $p < 0.001$; Kenny et al., 2014).

A global EMS score was calculated by combining the transformed total scores for each of the 18 individual EMSs. As anticipated, this was significantly positively correlated with K-MPAI scores, $r = 0.57$, $p < 0.001$. Correlational analyses also revealed significant positive relationships between the K-MPAI and all 18 EMSs, ranging from $r = 0.32$ to 0.54, $p < 0.02$–0.001 (see Supplementary Table 1). In order to explore latent factors underlying EMS patterns and themes that may predict the development of MPA, an exploratory factor analysis was conducted on the YSQ-S3 subscale scores using the principal axis method with direct oblimin rotation.

Based on eigenvalues and fit statistics, a four-factor model was found to be the *best fit* for the data. All four factors had eigenvalues greater than Kaiser's criterion of 1.0 and in combination explained 69.45% of the variance in MPA scores. The four rotated factors are outlined in Table 3, with 14 iterations required to reach the model. The Kayser-Meyer Olkin measure (KMO = 0.88) verified the sampling adequacy of the data, and Bartlett's Test of Sphericity, $\chi_{(153)} = 1173.40$, $p < 0.001$, indicated that the correlations between items were significantly large to support a principal axis factor analysis. These four factors were labeled according to descriptions of the EMSs provided by Young et al. (2003) and included Factor 1 = *Deprivation/Mistrust*, Factor 2 = *Ego Dysregulation*, Factor 3 = *Inadequacy/Impaired Autonomy*, and Factor 4 = *Undifferentiated Self*.

Tests of normality of the distribution of the four higher order factors were performed to ensure their suitability for further analyses. All factors revealed a skewness statistic of between z = 0.02 (Factor 3) and $z = 1.18$ (Factor 2), indicating that they all adhered to assumptions of normality and were appropriate for further parametric testing. Variable numbers were within those recommended by Cohen (1992) for a medium effect size at alpha = 0.05 with adequate power (0.80).

A multiple regression analysis of the four factors on K-MPAI scores, $F_{(4,95)} = 13.74$, $p < 0.001$, $R^2 = 36.70\%$ revealed that *Inadequacy/Impaired Autonomy* was the only significant predictor of MPA, $t_{(99)} = 3.06$, $p = 0.003$ (see Table 4). The individual EMSs loading onto this factor included *Failure to Achieve, Dependence/Incompetence*, and *Vulnerability to Harm or Illness*.

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TABLE 2 Mean, range, standard deviation, and distribution skew z scores for the K-MPAI total score and the YSQ-S3 subscales.

Measure	Min	Max	Mean	SD	Skew ratio z score
K-MPAI	61	186	122.53	27.34	0.5
Emotional Deprivation	5	29	9.85	5.99	6.42
Abandonment/Instability	5	30	10.72	5.76	6.14
Mistrust/Abuse	5	30	11.15	5.77	5.58
Social Isolation/Alienation	5	30	13.23	6.55	2.98
Defectiveness/Shame	5	30	10.26	6.32	5.84
Failure to Achieve	5	29	11.67	6.36	4.68
Dependence/Incompetence	5	23	9.11	4.49	4.77
Vulnerability to Harm or Illness	5	23	10.62	5.08	3.56
Enmeshment/Underdeveloped Self	5	25	8.31	4.39	6.89
Subjugation	5	25	11.41	5.09	3.25
Self-Sacrifice	5	30	17.01	5.17	1.73
Emotional Inhibition	5	29	12.47	5.82	3.07
Unrelenting Standards/Hypercriticalness	8	30	20.1	5.23	−0.92
Entitlement/Grandiosity	5	28	13.33	4.76	3.41
Insufficient Self-Control/Self-Discipline	5	29	12.67	5.45	2.68
Approval-Seeking/Recognition-Seeking	5	27	14.06	5.38	1.91
Pessimism	5	28	12.37	6.05	3.07
Punitiveness	5	30	13.14	5.55	2.9

Standard error of skew = 0.24.

2.3. Discussion

This first study investigated the relationship between EMSs and MPA in order to explore the link between early caregiver experiences and the cognitions and belief systems that contribute to MPA in adulthood. The results revealed significant positive correlations between all 18 EMSs and MPA, and a specific group of EMSs (Factor 3 in the exploratory factor analysis) was identified as a significant predictor of MPA in adult musicians. This group of EMSs included *Failure to Achieve, Dependence/Incompetence*, and *Vulnerability to Harm or Illness*. All three of these EMSs also fall within a broader theme (or "schema domain") as defined by Young et al. (2003) entitled *Impaired Autonomy and Performance*.

In addition to the EMSs within Factor 3 of the current study, Young et al. (2003) domain of *Impaired Autonomy and Performance* also includes the *Enmeshment/Underdeveloped Self* EMS, which did not emerge within Factor 3 of the current model. Indeed, in the population of musicians investigated in the study, *Enmeshment/Underdeveloped Self* appeared as a stand-alone EMS with its own independent significant factor loading (Factor 4), with minimal loadings onto other factors.

The variability between Young et al. (2003) *Impaired Autonomy and Performance* domain and Factor 3 of the current model it is not unexpected. Young's EMS domains were developed from a theoretical model rather than statistical analyses, and previous factor analytic investigations have revealed mixed support for their robustness (van Vlierberghe et al., 2010; Hawke and Provencher, 2012; Kriston et al., 2013; Bach et al., 2017). Due to the variability between Factor 3 and Young et al. (2003) domain, Factor 3 in the current model was redefined as *"Inadequacy/Impaired Autonomy"*, which we described as *'incorporating feelings and expectations of failure in the self, coupled with a sense of uncontrollability/external locus of control and associated feelings of vulnerability'*. This was based on overarching themes of schema content from each of the three EMSs included in the factor provided by Young and colleagues. It appears that for the population of musicians investigated in the current study, issues of individuation and personal identity associated with *Enmeshment/Underdeveloped Self* are independent of the Factor 3 themes and not predictive of MPA.

The inclusion of the *Dependence/Incompetence* EMS in Factor 3 suggests that a lack of practical self-efficacy may be a key component to understanding the EMS structure underpinning MPA. This facet of the current finding is consistent with recent research highlighting the role of self-efficacy in MPA (Egilmez, 2015; Orejudo et al., 2017; Robson and Kenny, 2017; Gill et al., 2022) and anxiety more broadly (Gallagher et al., 2013).

The current study extends previous research by placing self-efficacy in a schematic and developmental context. It suggests that the role of *Dependence/Incompetence* may reflect intrusive and over-involved or over-controlling parenting from a young age, leading to a depletion in a child's developing sense of self-efficacy and autonomy, and a sense of helplessness, dependency, and incompetence as they enter adulthood. This is supported by literature highlighting the role of overinvolved parenting in the development of poor self-efficacy and depleted feelings of autonomy in musicians (McPherson et al., 2012). The impact of

TABLE 3 Rotated factor loadings of the YSQ-S3 four factor solution.

Early Maladaptive Schema	Factor 1	Factor 2	Factor 3	Factor 4
Emotional Deprivation	**0.71**	0.41		
Abandonment/ Instability	**0.44**			
Mistrust/ Abuse	**0.54**			
Social Isolation/ Alienation	**0.77**			
Defectiveness/ Shame	**0.71**			
Subjugation	**0.44**		−0.32	
Self-Sacrifice	**0.56**			
Emotional Inhibition	**0.72**			
Unrelenting	**0.58**			
Standards/ Hypercriticalness	**0.46**		−0.32	
Pessimism	**0.60**			
Punitiveness				
Entitlement/ Grandiosity		**0.66**	0.40	
Insufficient Self-Control/		**0.45**		
Self-Discipline		**0.86**		
Approval-Seeking/ Recognition-Seeking				
Failure to Achieve	0.38		**−0.63**	
Dependence/ Incompetence			**−0.70**	
Vulnerability to Harm or Illness	0.38		**−0.33**	
Enmeshment/ Underdeveloped Self				**0.81**

Pattern Matrix data with loadings >0.3 presented. Principal axis factoring with direct oblimin rotation. Factor 1: Defectiveness/Deprivation; Factor 2: Ego Dysregulation; Factor 3: Inadequacy/Impaired Autonomy; Factor 4: Undifferentiated Self.

TABLE 4 Multiple regression analysis for MPA and the four EMS factors.

	B	SE B	β
Factor 1	3.55	2.42	0.18
Factor 2	1.5	1.76	0.09
Factor 3	9.65	3.16	0.37*
Factor 4	3.68	4.5	0.08

Factor 1: Defectiveness/Deprivation; Factor 2: Ego Dysregulation; Factor 3: Inadequacy/Impaired Autonomy; Factor 4: Undifferentiated Self. $R^2 = 0.37$; Adjusted $R^2 = 0.34$ ($p < 0.01$). *$p < 0.01$.

these feelings on performance confidence, perceived performance success, and coping skills for MPA may be pronounced, as poor self-efficacy is likely to produce a significant barrier to engaging in effective coping strategies due to beliefs that they are unattainable or futile (Gill et al., 2022).

Vulnerability to Harm or Illness, the second EMS in Factor 3, encompasses themes of helplessness and poor self-efficacy similar to that of *Dependence/Incompetence*. However, these themes are often framed in a tendency to worry, catastrophise, and perceive that the world is unsafe and unstable (i.e., they relate to feelings of helplessness due to core beliefs about the world being unsafe or imminent medical or psychiatric emergencies rather than focusing on an individual's perceived incompetence). The combination of *Vulnerability to Harm or Illness* and *Dependence/Incompetence* suggests a particularly debilitating mix of cognitions and beliefs in which an individual may harbor a deep dependency on others due to their poor self-efficacy, coupled with a pervasive belief that others (i.e., the world around them) will not be safe and will not support them. In the context of musical performance, this may manifest as anxiety regarding potential negative repercussions of performance and audience feedback (expectations of harm and catastrophe) coupled with a lack of sense of control or capacity to manage the pressures of the performance adequately (a sense of dependence and incompetence). This has been demonstrated in previous studies in which musicians' "catastrophic" fears were identified as a fear of negative evaluation (Osborne and Franklin, 2002; Osborne and Kenny, 2008), and fear of negative evaluation has been consistently associated as a key component of Social Phobia (Heinrichs and Hofmann, 2001; Stopa and Clark, 2001; Weeks et al., 2005).

The inclusion of *Failure to Achieve* in the current model could be anticipated from previous findings highlighting the strong relationship between perfectionism and MPA (Mor et al., 1995; Patston and Osborne, 2016). Similarly, poor self-efficacy, perceived inadequate preparedness, debilitative perfectionism, and an external locus of control have all been associated with musicians' performance experiences and performance satisfaction (Clark et al., 2014).

The inclusion of *Failure to Achieve* in Factor 3 of the current model further reinforces themes of perceived inadequacy, poor self-efficacy, and an external locus of control. These themes are central to *Failure to Achieve* and similarly underpin *Dependence/Incompetence* and *Vulnerability to Harm or Illness*, and they represent a clear and consistent range of psychological vulnerabilities. These vulnerabilities are likely to develop from a mixture of temperamental factors and early life experiences with primary carers (Young et al., 2003) and together they are predictive of MPA in adulthood. Indeed, various researchers have reported relationships between parental overprotection, hostility, and low levels of parental care in the development of each of the EMSs highlighted in the current model (Shah and Waller, 2000; Harris and Curtin, 2002; Lumley and Harkness, 2007; Haugh et al., 2017).

2.3.1. Early environment predictors of MPA and parenting implications

As previously described, Young outlines several *core emotional needs* that are key to the healthy psychological and social development of a child, and without which a child may

be more vulnerable to developing an EMS (Young et al., 2003; Lockwood and Perris, 2012). Given the moderate to strong correlations found between all EMSs and MPA in the current study, Young's aetiological model indicates that parenting experiences early in a child's life warrant further attention in regards to their potential role in the emergence of MPA in adulthood.

According to Young et al. (2003), EMSs from the *Impaired Autonomy/Performance* domain (which includes all Factor 3 EMSs) typically develop from a family background characterized by enmeshment, undermining of a child's confidence, overprotection, or failing to reinforce the child for performing competently outside the family; a proposition that has received empirical support in non-musician populations (Harris and Curtin, 2002; Haugh et al., 2017). Whilst the *Enmeshment/Underdeveloped Self* EMS was not included in Factor 3 of the current model, these general themes of parental overprotection, overcontrol, and undermining of the child's confidence are likely to be similar for individuals who scored high on Factor 3.

Parental criticism, parental overprotection, and parental shaming have also all been previously identified as being significantly associated with the development of Social Phobia (Parker, 1979; Arrindell et al., 1983; Hudson and Rapee, 2000; Neal and Edelmann, 2003; Asbrand et al., 2017) and parental over-involvement has been shown to be significantly associated with the development of anxiety disorders in general (McLeod et al., 2007; van der Bruggen et al., 2008). Given that patterns of overcontrolling parenting have similarly been shown to undermine autonomy, self-efficacy, and intrinsic motivation in young musicians (McPherson et al., 2012), the need to address parenting styles (particularly overcontrol and criticism) to minimize the development and severity of MPA in children and adolescents (and subsequently adults) may therefore be of particular importance.

2.4. Study 1 conclusions

By exploring the relationship between EMSs and MPA in adulthood, Study 1 identified typical maladaptive cognitive schema patterns experienced by musicians with MPA. Through this investigation, likely childhood environments associated with those particular clusters of EMSs could be posited based on Young's theory and existing empirical research. Study 1 findings suggest that if core emotional needs of children are not met by primary carers, particularly through overcontrolling or overprotective parenting styles, this may contribute to the development of a combination of EMSs (namely *Failure to Achieve, Dependence/Incompetence,* and *Vulnerability to Harm or Illness*). Collectively these EMSs, which are characterized by expectations of failure, a sense of incompetence and dependence, and an expectation of catastrophe and concurrent sense of vulnerability in adulthood, are a significant predictor of MPA in adulthood.

3. Study 2: recollections of childhood experiences with caregivers by adults with MPA

Study 2 extended Study 1 findings by interviewing musicians who experience MPA and explored their early life experiences with caregivers, providing developmental information to contextualize the findings from Study 1.

3.1. Method

3.1.1. Participants

Study 2 participants were selected from participants who scored +/- 1.5 standard deviations from the mean K-MPAI score of 122.53 (SD = 27.34). This cut-off was chosen to gain an adequate sample size for comparative interviews and meaningful qualitative data analysis, based on willingness and responsiveness of participants from Study 1. The final sample comprised three low scorers (K-MPAI range = 87–91), and five high scorers (K-MPAI range = 148–179), capturing the range of MPA.

3.1.2. Procedure

Participants completed a semi-structured interview comprising open-ended questions that focused on parenting styles highlighted in the EMS research outlined in Study 1 Introduction. Themes included levels and styles of parental involvement, discipline, punishment, love expressed, and encouragement. The interviews ranged from 49 min to 144 min, varying due to the levels of detail, insight, tangentiality, and life experiences of the participants.

3.1.3. Data analysis

Interpretative Phenomenological Analysis (see Pietkiewicz and Smith, 2014) was used to perform a qualitative analysis of transcribed interview data. This enabled a descriptive account of the data provided by participants in relation to their early social experiences, musical development, and current experiences of MPA and EMS patterns. Analyses were performed using qualitative data analysis computer software package, NVivo 11, to assist in drawing out and examining common themes. In presenting the results of the analysis, participant names and non-essential details have been changed to preserve confidentiality.

3.2. Results

Participants with high K-MPAI scores demonstrated an overall elevation across EMS scores compared to those with low K-MPAI scores (see Table 5), though variability is evident within individual EMS profiles.

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TABLE 5 Demographic data, K-MPAI, and YSQ-S3 scores for Study 2 participants.

	Low MPA Group			High MPA Group				
	LowMPA-1	LowMPA-2	LowMPA-3	HighMPA-4	HighMPA-5	HighMPA-6	HighMPA-7	HighMPA-8
Gender Age (years) Instrument type Experience (years) Role of music	F 35-44 Strings 21+ Professional full-time	F 25-34 Woodwind 21+ Amateur	M 35-44 Woodwind 21+ Professional part-time	F 25-34 Strings 21+ Professional full-time	F 35-44 Strings 21+ No longer playing	F 45-54 Strings 21+ Amateur	F 55-64 Woodwind 21+ Professional part-time	M 55-64 Keyboard 21+ Amateur
MPA*	90	87	91	179	150	148	161	155
Emotional deprivation			2.6		2.6	2.8	2.6	5.6
Abandonment				3.6				2.6
Mistrust/abuse					3.4		4.4	
Social isolation					3.6	4.6	5.0	4.6
Defectiveness/ shame							3.8	3.4
Failure to achieve		2.2		2.8	5.6	3.2		2.6
Dependence/ incompetence					3.4			
Vulnerability to harm				4.0	3.6		2.8	2.8
Enmeshment								
Subjugation					4.6	3.0	3.6	3.4
Self-Sacrifice	3.2	3.0	3.2	3.4	4.8	4.2	3.2	3.0
Emotional inhibition						3.8		
Unrelenting standards	3.2	4.4	4.0	4.8	3.8	3.6	3.6	4.4
Entitlement		3.6		2.8		2.8	5.4	
Insufficient self-control				4.6	4.0			3.8
Approval-seeking		5.0		3.2	2.8		4.8	3.2
Pessimism				3.8	3.6	2.8	3.0	3.6
Punitiveness				3.8	3.2		4.2	3.8

Only the YSQ-S3 scores that exceed Axis I clinical outpatient norms provided by Hawke and Provencher (2012) are provided.
*MPA (K-MPAI) mean score for overall Study 1 sample = 122.53 (SD = 27.34).

3.2.1. Key parenting themes

Key parenting themes were explored in the data (see Table 6), and comprised various aspects of parenting styles and behaviors, including levels and types of parental involvement, regulation and stability of parental emotional expression, and the way in which love is expressed. Table 6 outlines these key parenting themes alongside examples of associated adaptive and maladaptive home environments as described by participants.

3.2.1.1. Affection/expression of love

This key parenting theme relates to a child's consistent knowledge that they are loved and valued, whether this is expressed by caregivers physically, verbally, or via other more indirect means.

Participants with high MPA described home environments typically characterized by varying degrees of emotional or practical neglect. Demonstrations of love or affection were often provided unreliably or were coupled with other needs not being met:

> Of course, we were all loved, but we were never told it. No one was ever told "I love you", ever…I can remember when I was a little kid, [Mum] would always be standing at the sink washing the dishes, and coming up behind her and just holding her around the legs or around the waist or something like that, giving her a hug like that, and she never really accepted it easily…So long as you weren't being yelled at, the rest of the time you were meant to infer that things were ok and everything was alright. [HighMPA-7]

Another respondent described contradictory and varied memories of his mother during his childhood, responding at one point:

> I don't remember any physical contact with my mother. [HighMPA-8]

TABLE 6 Study 2 core themes and adaptive and maladaptive descriptions identified in the qualitative analysis.

Key parenting theme	Adaptive home environment	Maladaptive home environment
Affection/expression of love	Overt demonstrations of affection and love (physically, verbally, or other non-verbal demonstrations) apparent to child	Lack of affection or conflicting messages of love, child feels unloved
Soothing and safety	Provision of soothing when a child feels afraid or distressed, provision of a 'safe, stable base'	Emotional needs not met, child feels unprotected and isolated
Parental involvement	Parents' active and non-judgemental involvement in the child's daily life and musical activities	Child's practical daily needs and interests not supported
Parental encouragement and support	Demonstrations of emotional support, unconditional praise and encouragement	No support or encouragement, parent is disinterested or critical, or encouragement is provided conditionally
Parental expectations	Parents provide unconditional support of child's intrinsic motivation and interests, support of the child's engagement and attempts	Comparisons of child to peers, parental investment in musical outcomes or own agendas, focus is only on child's successes
Parental anger and rage	Predictable and stable mood in parents, appropriateness of parental emotional responses to disciplining and their own stress	Demonstrations of angry behavior (e.g., explosive verbal outbursts), criticism, unpredictability of outbursts

At another point, the respondent described his mother's soothing and physical affection when he was distressed following a soiling incident as a young child, stating:

> Mum was very affectionate, and she still is. [HighMPA-8]

However, this participant also described violent, unpredictable episodes of rage by his mother at other times (see *Parental Anger and Rage*), reflecting strongly conflicting and unstable messages of love and affection provided by her.

In contrast, participants with low MPA described reliable and stable experiences of affection and love in their home environments, whether expressed physically, verbally, or demonstrated less overtly:

> [My parents] were very affectionate people…We always kiss each other. We're always saying "I love you" …I'm very blessed in that I had a really supportive and loving family. [LowMPA-2]
>
> [My parents have] always been very loving and very affectionate. My Dad was always demonstrably affectionate with his two sons...Mum's a very loving person. A huge capacity for love. So I would describe my upbringing as loving. That's the word...We were definitely told explicitly that we were loved. And shown physically. [LowMPA-3]
>
> [My parents were] definitely supportive and affectionate. They weren't very physically or verbally affectionate, but they were very supportive. But neither of them are particularly demonstrative people…I felt safe and very looked after. [LowMPA-1]

3.2.1.2. Soothing and safety

This key parenting theme relates to the availability and consistency of soothing provided by parents to enable a child to form a safe and stable emotional base from which they can develop confidence and experience the world as a safe and supportive place.

Many high MPA participants described experiences in which their parents were not consistently available for emotional support or soothing. The impacts of these reported experiences are similar to those of lack of parental affection, as they appear to have contributed to participants' developing feelings of anxiety, lack of self-efficacy, poor self-worth, self-reliance, and sense of uncontrollability or unreliability about the world around them.

> I'd never go to my Mum [for affection]. I went to her once about something and the [shit] really hit the fan. She couldn't cope…I don't remember any physical contact with my mother…My brother and I were always on edge. [HighMPA-8]
>
> My bedroom was right at the end [of the corridor] and I was afraid of the dark. Mum would say "You have to go to bed now" and I'd say "I can't go out there; It's all dark" and then she'd go [to my sister] "Oh God, take [your sister] out there. She's scared of the dark!" She used to make out like I was a pain in the neck. [HighMPA-7]
>
> So I was 14 months old when [my next younger sibling] was born and I think she was quite a needier kid than I was as a baby, so I think I probably just learned to be quite self-contained because she cried a lot and needed attention as a baby and I was just happy to play by myself or whatever.…And my youngest sister was premature so she got a lot of attention obviously as a little one…A 14-month-old kid is a baby. You don't want to be left to do your own thing at 14 months. The baby doesn't want to be left alone. But that was out of necessity. How do I think that affected me? I think I've just learned to become a bit more self-contained. Not expecting that someone's going to come and entertain me, or attend to me straight away. I tend to as an adult, as a result of that, I look for my own solutions really…I used to get scared a lot in the night as a kid. I thought there were boogeymen out the window and sharks under the bed…if I woke up and felt scared, I would jump out of the bed wide enough to not get caught by the wolves or sharks under the bed and then I'd go and just sit next to Mum and Dad's bed on Mum's side, just to be close to them. But I wouldn't always wake them up…because

> I didn't want to intrude really. So I'd just sit there and wait and sometimes, after a while, Mum would wake up and see me sitting there. [HighMPA-6]

Of the low MPA participants, memories of soothing and safety were expressed in differing ways, but each participant described a safe, stable base.

> [My Mum] was a nurse, so she had that kind of capable thing as well. She was very practical and capable. If I was in tears, [I'd go to] my Mum. Definitely my Mum. Physical comfort. Definitely affection. So I felt safe and very looked after. [LowMPA-1]
>
> [I would go to] my Mum. Hugs and kisses and pats on the back and being told it's all ok. [LowMPA-3]

3.2.1.3. Parental involvement

This theme relates to parents' active and non-judgemental involvement in the child's daily life. It incorporates involvement of parents in day-to-day practical parenting tasks (such as meals, bedtime stories, after school care) along with involvement in the child's learning, both in school and extracurricular activities.

Several participants with high MPA recalled their parents not providing for them or supporting them adequately in practical day-to-day needs:

> At home, when we were playing, our Mum never played with us at all. Didn't use to read us stories at night. [HighMPA-6]
>
> I just don't remember that [my parents] were around that much…I remember Dad doing a lot of the cooking, but it was very basic 'soup a la Dad': Brown some mince, put a couple of cans of soup in and a chunk of frozen mixed vegetables. Ready in 20 minutes, and then they'd both be off…They would have been able to put us to bed I guess. We would come home from school and there would be babysitters…Mostly we'd just sit there and watch telly or whatever. [HighMPA-5]

This was coupled with recollections by some high MPA participants that they were not taught basic daily living skills that would have assisted with increased autonomy and confidence as they entered adulthood:

> [My mother] just did stuff. She certainly didn't delegate. Even when we got older, she just did it all. I never learned how to cook until I moved out of home. Even the washing. We would say "Mum, why don't you get us to put on the washing?" and she just never did…A bit of a martyr syndrome thing going on…I felt angry because it did impact on us…because in a way, she projected her feeling of martyrdom and we had to carry the burden of being the burden for her. And I felt angry about that. [HighMPA-6]
>
> We had a cleaning lady who would come, but I didn't really learn how to…I had no idea when I left home how to operate a washing machine…I was pretty useless as a human being other than I could play the piano reasonably well. [HighMPA-5]

Conversely, the strong focus on music practice was a theme in the high MPA participants:

> [Mum] tells me now that 'I was expecting you to practice every day, so I felt like that was enough'. That she didn't expect us to tidy our rooms as well. Personally, I think that's a mistake. I think she's got it topsy turvy. [HighMPA-5]

Parents of high MPA participants were in some cases remembered as having critical and/or personal involvement in their child's music practice and achievements, or in other cases being completely disengaged and disinterested:

> I know at one point [my mother] had 100 students [as an instrumental music teacher]. On top of that was this eisteddfod and running her violin ensembles…maybe she just couldn't say no. If someone wanted to learn violin, she felt obliged to teach them because she felt if she didn't do it, there was no-one else. But her loyalty was there…One thing I have wondered is, on some level I was made to feel I was somehow special by my parents, by my Mum. I think by not having to do chores around the house or contribute to the household but also being always made to practice…because of this musical training…I felt like I was – it sounds really embarrassing and juvenile – that I was special in some way. I had this underneath idea that I was better than other people because I played an instrument…But at the same time, I had this feeling of total incompetence or worthlessness. [HighMPA-5]
>
> [Mum] never came to any lessons, ever [and] Dad had very little part in my life. He was like a background shadow…[but] the classic thing was you'd be doing your piano practice and [Mum would] be in the kitchen doing something like the dishes or making the dinner or whatever, and then she'd just go insane! She'd go "No! No! That's wrong! That's wrong!!" and she'd come running into the room and say "That's wrong! You have to do this!" And you'd have to do that! [HighMPA-7]

In contrast, all the participants with low MPA recalled involvement by their parents in daily activities and daily life, describing encouraging and safe environments, actively supporting intrinsic motivation and valuing family connection:

> My poor father was a taxi driver [driving me to rehearsals and concerts throughout the week]… We [also] played sport together as a family every week. From my early teens until I left home, we played badminton and table tennis every Saturday night at the local sports center. [LowMPA-2]

3.2.1.4. Parental encouragement and support

This key parenting theme relates to the demonstrations of non-judgemental encouragement, emotional support, and unconditional praise provided by parents. Participants with high MPA frequently described only conditional praise when reflecting on their parents' provision of encouragement and support:

> It seemed like you'd only get attention if you did something good…You'd get told off enough, but you wouldn't get positive affirmations. It felt like the only time that you'd get positive

> affirmations was when you do something that my Mum could brag about. I think both my Mum and Dad were insecure and felt inferior, so the fact that she'd have something so she could say "My daughter's better than you". [HighMPA-7]

Other high MPA participants reported of a lack of encouragement expressed by parents entirely:

> [During music practice] I remember some pretty awful times actually. I remember us both screaming at each other. [Mum] crying but still sitting next to me, making me do it. I don't remember any nice things about that. [HighMPA-5]

Of the low MPA participants, experiences were described as consistently supportive, free from specific expectations by parents, and encouraging of freedom and autonomy:

> They expected us to be quite independent. But they were very supportive of things that we wanted to do. I never felt like it was their expectation for doing things that was driving any of the things that we did at school. There was very much a feeling of what we did was up to us. [LowMPA-1]
>
> My parents] always encouraged me and my brother as well, to do whatever we liked, and whatever interested us to follow up to the nth degree. Very supportive. Although they weren't from a musical family themselves. [LowMPA-3]

3.2.1.5. Parental expectations

This key parenting theme relates to parenting styles that focus on particular vested interests and outcomes rather than a child's intrinsic motivation. It was often implemented through overcontrol and criticism, and frequently incorporated comparisons with other children.

Of the high MPA participants, expectations regarding music training were high, though they were associated with differing parental agendas:

> Mum was the president of the [local] eisteddfod, so she ran this big music competition every year…and so I was made to go in it every single year. Most of the time I wouldn't even get a place. And I just remember, I would just be devastated and howling on the bed, and it was just awful…I think there was this pretty strong message there with how I performed was linked to my value as a person, to be honest. Because not very much time was spent with my [parents] other than being concerned with whether or not I had practiced. [HighMPA-5]
>
> I think my Mum had this idea that we had to be 'perfect ladies'. She used to say that to me and my sisters and had this idea of what perfect ladies should be. We had to have gloves, fancy dresses, a handbag. I never really knew what the handbag was about. I'd say to her "What's a handbag for?" and she'd say "You have to keep your hanky and your bottle of perfume". This was in primary school, from probably around eight or nine…Part of 'being a lady' was that you had to be able to play the piano." [HighMPA-7]
>
> [I remember one time] where I couldn't find my school shoes and I hadn't practiced so I wasn't allowed to go to school, and by the time I'd got to school, I remember having to be taken out of the classroom very quickly because I must have been hysterical. I was about seven. And I remember telling the teacher that Mum had told me that if I didn't do my practice and didn't do things properly I wouldn't get to go to university. [HighMPA-4]

In contrast, all participants with low MPA uniformly recalled their parents' unconditional support of their interests and autonomy:

> It never felt like I should have done better in [Mum's] eyes. She was pretty unconditional about that. If this is what you want to do, then we'll support it. I never felt like I wasn't good enough…I never felt like I was letting my mother down with anything that I did. As long as I tried, I think she was really fine with that. [LowMPA-1]
>
> My parents didn't push me to do stuff…I really loved school and the learning experience, and the group dynamics of playing in ensembles and the solo instrument as well. That appealed to me as well and I got good at it quite quick. [LowMPA-2]

3.2.1.6. Parental anger and rage

This key parenting style relates to experiences of unpredictable and/or explosive anger outbursts by parents, which were described by several participants with high MPA:

> We were really scared of our Mum. My parents had their own mental health problems, so I can remember coming home and my older sisters would say "Mum's in a bad mood!" and we'd go somewhere and hide because we didn't want to get near her. Her rage was just really, really scary. Yeah, she would hit us. But was mostly her rage that you were most afraid of…Basically I've grown up feeling that I'm a bad person and I find it really, really hard to throw that off. That I'm always worrying that I'm going to be criticized and what I've done wrong now…I think I just go about with the expectation that people aren't going to accept me for what I am. [HighMPA-7]
>
> My Mum is quite a highly anxious person. Very, very stressed, and has depression. I think that was all undiagnosed when we were small and that's come to light. Lots of conversations about that stuff now and how it has affected us. Very, very angry. Lots of anger…I think that was her way of expressing things. Her struggles came out in quite an angry way and often directed at us. I remember being in trouble a lot. I would get smacked a lot. I was quite scared of her because of that side of her personality. I remember being very stressed and very upset as a child. I remember a lot of crying and a lot of sick in your stomach feeling because of the tension in our house. There was a lot of fighting…I think as a child I just would have felt a lot of the time that I was bad and naughty, and I don't know if that's actually true, but I do remember feeling guilty that I was bad as a child. I think I have the capacity to take things on and feel responsible for them. I feel guilty and like 'Could I have done that better? Is it my fault?'. [HighMPA-4]
>
> Mum is terrifying and wonderful at the same time…So, things were sometimes quite frightening when I was a

> kid…Mum was violent. She suffered quite badly from rages [HighMPA-8]
>
> When [Mum] was angry, it was never outwardly expressed. She was a passive aggressive angry person. She'd slam cupboard doors and bang pot lids and you'd stay out of her way until she went and got more normal again. We didn't deal with emotional stuff outwardly at all when I was growing up. [HighMPA-6]

3.3. Study 2 conclusions

Broadly, the developmental etiology suggested by the current findings is consistent with prior research highlighting the role of overcontrolling, neglectful, and critical parenting in the development of EMSs (Shah and Waller, 2000; McGinn et al., 2005; Haugh et al., 2017). Findings also reflect previously established associations between parental criticism, parental overprotection, and parental shaming and the development of Social Phobia (Parker, 1979; Arrindell et al., 1983; Hudson and Rapee, 2000; Neal and Edelmann, 2003; Asbrand et al., 2017). Furthermore, the impact of parental expectations and overcontrol has been noted in parents of young tennis players, for whom the pressures of elite performance bear many similarities to those of performing musicians (Gould et al., 2006).

Findings similarly reinforced prior research identifying the detrimental impact of parental overprotection and overcontrol on the development of autonomy and intrinsic motivation in children (Ryan and Deci, 2002; McPherson et al., 2012; Haugh et al., 2017). In the current study, parental expectations relating to children's music goals and parental aggression and control associated with music practice described were frequently described as contributing to poor identity development outside music, poor autonomy, poor self-efficacy, high anxiety, and feelings of inadequacy by participants with severe MPA.

The conditional praise and frequent criticism described by high MPA participants similarly appeared to impede development of confidence, self-efficacy, intrinsic motivation, and a robust and identity outside of music. The impact of parental support (practical and emotional support, and support of developing autonomy) on the ongoing engagement and enthusiasm for music training in children is well established (McPherson and Davidson, 2002), and the current findings begin to shed light on the longer-term impacts of overcontrolling, neglectful, and critical parenting on musicians as they enter adulthood, both in terms of the development of MPA and broader mental health difficulties. The recollections of parental overcontrol coupled with poor parental support echo the description of Barlow (2000) "psychological vulnerability" in the context of MPA development as described by Kenny and Osborne (2006), who suggested that MPA may develop in part as a result of a home environment in which parental expectations for excellence are high but support for achieving excellence is low. Participants high in MPA who described parental aggression and verbal abuse in childhood also reflected on the role of these experiences in producing a constant sense of fear and anxiety, distress, and poor self-worth. A wealth of prior research has identified that parental verbal abuse, aggression and antipathy (including rejection, criticism, and hostility) predict anxiety, depression, self-criticism, fears of rejection, and separation anxiety in adolescents and adults (Sachs-Ericsson et al., 2006; Teicher et al., 2006; Schimmenti and Bifulco, 2015).

In consideration of the key parenting styles identified in Study 2, the first three of Young et al. (2003) *core emotional needs* appear to be particularly applicable when exploring aetiological vulnerabilities associated with the development of MPA, namely, (1) Secure attachments to others; (2) Autonomy, competence, and a sense of identity; and (3) Freedom for the child to express valid needs and emotions. These *core emotional needs* align closely with the content of the five key parenting themes, and further support the impact of a *generalized psychological vulnerability* as proposed by Barlow (2000). Through the lens of Barlow's model, MPA may in part stem from childhood experiences in which the opportunity for the development of a sense of control over salient events is absent. These experiences may be characterized by a lack of stability and nurturance, emotional neglect, unpredictable, explosive anger, and a lack of parental support for the development of autonomy and identity (through extrinsic motivation, poor support for a child's intrinsic interest and needs, and parental overcontrol). As proposed by Barlow and supported by the high MPA participants in Study 2, these early environments appear to contribute not only to the development of broader mental health difficulties and dysfunctional cognitive styles (as demonstrated by elevated EMS score profiles) but most pertinently to the development of debilitating MPA.

Study 2 clarifies what children and adolescents do need for healthy psychological development and minimizing the development of MPA; namely, the provision of parenting styles that were absent in the participants who experienced severe MPA and present in those who experienced minimal MPA. These include active parental involvement and availability in the child's life and musical training, but this must be in a facilitating environment that engenders the development of intrinsic motivation and autonomy in the child, and provides them with an opportunity to develop their own sense of identity; in the words of McPherson (2009), to provide "scaffolding" for the child's own developing interests. Additionally, an emotionally secure, stable home environment in which the parent is consistent in providing appropriate encouragement and affect in their responses, is important for the child to develop feelings of safety and control in the world, and to develop their sense of self-worth and self-efficacy.

4. Discussion

These studies investigated a potential aetiological pathway from parenting experiences in childhood and adolescence to the development of cognitive and social schemas relevant to MPA in adulthood. Using a quantitative analysis, Study 1 provided support for the role of EMSs in the development and experience of MPA, particularly those associated with themes of failure, expectations of harm or catastrophe, feelings of vulnerability, and a sense of incompetence and dependence. Through an in-depth qualitative interview, Study 2 extended these findings by identifying key parenting themes that appear to be associated with vulnerability to the development of MPA in adulthood. These key

parenting themes include Affection/Expression of Love, Soothing and Safety, Parental Involvement, Parental Encouragement and Support, Parental Expectations, and Parental Anger and Rage. Whilst the findings from both studies cannot provide a causal relationship between parenting styles, the development of EMSs, and the development of MPA, they provide a strong foundation for particular themes and vulnerabilities that may typically be associated with such an aetiological pathway.

4.1. Implications

By increasing our understanding of the effect of early social experiences on the development of MPA, there are implications not only for clinical intervention, but for shaping early home environments and music education environments to support young musicians in building resilience and minimizing the development and impact of MPA.

4.1.1. Parenting implications

While Study 1 revealed particular EMSs that were collectively predictive of MPA, variable EMS profiles were evident in the small sample of high MPA participants in Study 2. Nevertheless, at least one of the five key parenting themes was evident in each of the high MPA participants, and each were markedly different in their accounts of childhood parenting experiences from those in the low-MPA group.

Practical support and interventions for parents may take the form of education by music teachers and clinicians regarding the parents' need for an active, non-judgemental role in a child's music practice, their support and encouragement of a child's intrinsic motivation and engagement in music, and the importance of fostering autonomy and confidence. Given the associations between critical and overprotective parenting styles and anxiety disorders more generally, the need for parents to adopt healthy and adaptive parenting styles beyond a child's musical education may be vital not only in mitigating the development or severity of MPA in adulthood, but also in supporting the child's developing resilience and psychological wellbeing.

4.1.2. Instrumental learning implications

The impact of teachers may be understood as secondary to that of parents as their role in the child's life is less involved and more focused. Nevertheless, children and adolescents who learn a musical instrument are likely to spend significant time with teachers and in music education programs if they are thoroughly engaged in their learning and if they are likely to continue on their musical trajectory either as an amateur or professional musician (McPherson et al., 2012). As such, the relationships with key individuals and the social environments experienced whilst learning music are likely to be important factors in developing resilient musicians who are able to manage the pressures of performing and remain connected to the intrinsic joys of music-making. As with parenting practices, the current study highlights the need to foster autonomy, confidence, and self-efficacy within these environments whilst providing non-judgemental support and encouragement, all of which have been previously identified as important in improving music students' motivation and engagement (McPherson et al., 2012). Teachers may also have the capacity to mitigate the impact of damaging parenting influences such as criticism, lack of interest, or overcontrol through psychoeducation and modeling as described above.

4.1.3. Treatment implications

Findings suggest that identification of individual EMS profiles may be of particular assistance in clinical settings when addressing the aetiological underpinnings of MPA presentations in adults. While Study 1 revealed overall patterns of EMSs that predicted MPA, the diversity in individual EMS profiles observed in the small Study 2 sample is consistent with prior research demonstrating the breadth of EMSs that can be associated with particular parenting experiences (e.g., Harris and Curtin, 2002; Lumley and Harkness, 2007; Haugh et al., 2017). Nonetheless, both studies indicate the value in investigating early life experiences and EMS profiles when treating MPA in adults. In this clinical context, Young's Schema Therapy approach (Young et al., 2003) may provide a valuable therapeutic framework to enable dysfunctional interpersonal patterns and belief systems about the self to be reshaped and healed through.

Schema Therapy incorporates the therapeutic relationship as a model for healthy interpersonal functioning and addressing core emotional needs, assisting the client in identifying past dysfunctional schema patterns, and developing adaptive coping styles to recover from past dysfunctional schema patterns (Young et al., 2003). Schema Therapy has gained empirical support as an effective treatment for personality disorders (Sempértegui et al., 2013; Bamelis et al., 2014; Arntz et al., 2022) and cautious support as a treatment for Axis I disorders (van Vreeswijk et al., 2014; Peeters et al., 2021; Straarup et al., 2022). As such, Schema Therapy warrants consideration as a potentially effective psychodynamic therapeutic approach for MPA, but further empirical support is needed. Whether or not a semi-structured treatment such as Schema Therapy is adopted, however, the understanding of a client's underlying EMS profile may still illuminate underlying treatment needs for a client with elevated MPA levels. For example, Study 1 indicates that themes of helplessness, a lack of self-efficacy, and beliefs and expectations of failure are significantly predictive of MPA in adult amateur, student, and professional musicians. As such, understanding and working with confidence, autonomy, self-efficacy, and personal strengths may be of particular assistance in reducing long-term vulnerabilities to MPA over-and-above practical strategies to assist with performance-based skills and relaxation.

4.2. Limitations and further explorations

Whilst robust quantitative and qualitative findings emerged from the current studies, there are several limitations identified that may assist in further consolidating and extending findings.

Firstly, Study 1 had an adequate sample size for statistical power (Cohen, 1992). However, replication with a broader and larger

sample would be of benefit in providing further support for the findings, and would enable an assessment of the role of individual EMSs in the development of MPA rather than providing only a predictive model of higher-order factors.

Secondly, additional psychometric data illustrating retrospective accounts of early parenting experiences would enable analysis of a broader adult sample for future research. For example, replication of Study 1 with the inclusion of the Young Parenting Inventory (YPI; Young, 2014); a psychometric measure that specifically assesses retrospective accounts of parenting experiences in childhood that are thought to be associated with particular EMSs, would deepen our understanding of the relationship between childhood parenting experiences, EMSs, and MPA in adulthood.

Thirdly, an examination of EMS constructs in more depth would enrich the current findings; in particular, an investigation of the potential role of schema "modes" (referring to the active manifestation of an EMS and its associated coping response; Young et al., 2003) during pre-performance and performance experiences, and primary and secondary pathways to EMSs.

Finally, further studies may benefit from including an assessment of psychiatric disorders (particularly Social Phobia) which may assist in elucidating/differentiating more generalized risk factors from early childhood parenting experiences and those that are more specifically associated with the development of MPA.

Data availability statement

The datasets presented in this article are not readily available because participants of this study were not asked to consent for their data to be shared publicly. Requests to access the datasets should be directed to mosborne@unimelb.edu.au.

Ethics statement

The studies involving human participants were reviewed and approved by the University of Melbourne Human Ethics Research Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

JK designed and executed the study, performed the analysis, and wrote the manuscript. SW and MO collaborated in the study design, methodology, analysis, and writing of the paper. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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References

APA (2022). *Diagnostic and Statistical Manual of Mental Disorders*. New York, NY: American Psychiatric Publishing.

Arntz, A., Jacob, G. A., Lee, C. W., Brand-de Wilde, O. M., Fassbinder, E., Harper, R. P., et al. (2022). Effectiveness of predominantly group schema therapy and combined individual and group schema therapy for borderline personality disorder: A randomized clinical trial. *JAMA Psychiatry* 79, 287–299. doi: 10.1001/jamapsychiatry.2022.0010

Arrindell, W. A., Emmelkamp, P. M. G., Monsma, A., and Brilman, E. (1983). The role of perceived parental rearing practices in the aetiology of phobic disorders: a controlled study. *Br. J. Psychiatry* 143, 183–187. doi: 10.1192/bjp.143.2.183

Asbrand, J., Hudson, J., Schmitz, J., and Tuschen-Caffier, B. (2017). Maternal parenting and child behaviour: An observational study of childhood social anxiety disorder. *Cognit. Ther. Res.* 41, 562–575. doi: 10.1007/s10608-016-9828-3

Bach, B., Lockwood, G., and Young, J. E. (2017). A new look at the schema therapy model: organization and role of early maladaptive schemas. *Cognitive Behav. Ther.* 46, 1–22. doi: 10.1080/16506073.2017.1410566

Bamelis, L. L. M., Evers, S. M. A. A., Spinhoven, P., and Arntz, A. (2014). Results of a multicenter randomized controlled trial of the clinical effectiveness of schema therapy for personality disorders. *Am. J. Psychiatry Off.* 171, 305–322. doi: 10.1176/appi.ajp.2013.12040518

Baranoff, J., Oei, T. P. S., Cho, S. H., and Kwon, S. (2006). Factor structure and internal consistency of the Young Schema Questionnaire (Short Form) in Korean and Australian samples. *J. Aff. Dis.* 93, 133–140. doi: 10.1016/j.jad.2006.03.003

Barlow, D. H. (2000). Unravelling the mysteries of anxiety and its disorders from the perspective of emotion theory. *Am. Psychol.* 55, 1247–1263. doi: 10.1037/0003-066x.55.11.1247

Barlow, D. H. (2002). Anxiety and Its Disorders. The Nature and Treatment of Anxiety and Panic. London: Guilford Press.

Brotons, M. (1994). Effects of performing conditions on music performance anxiety and performance quality. *J. Music Ther.* 31, 63–81. doi: 10.1093/jmt/31.1.63

Chang-Arana, A. M., Kenny, D. T., and Burga-León, A. A. (2017). Validation of the kenny music performance anxiety inventory (k-mpai): a cross-cultural confirmation of its factorial structure. *Psychol. Music* 7, 1–17. doi: 10.1177/03057356177 17618

Clark, T., Lisboa, T., and Williamon, A. (2014). An investigation into musicians' thoughts and perceptions during performance. *Res. Stu. Music Educa.* 36, 19–37. doi: 10.1177/1321103X14523531

Cohen, J. (1992). Statistical power analysis. Curr. Directions Psychol. Sci. 1, 98–101. doi: 10.1111/1467-8721.ep10768783

Cox, W. J., and Kenardy, J. (1993). Performance anxiety, social phobia, and setting effects in instrumental music students. *J. Anxiety Disorders* 7, 49–60. doi: 10.1016/0887-6185(93)90020-L

Egilmez, H. O. (2015). Pre-service music teachers' piano performance self-efficacy belief inversely related to musical performance anxiety levels. *Educ. Res. Rev.* 10, 2558–2567. doi: 10.5897/ERR2015.2439

Eng, W., Heimberg, R. G., Coles, M. E., Schneier, F. R., and Liebowitz, M. R. (2000). An empirical approach to subtype identification in individuals with social phobia. *Psychol. Med.* 30, 1345–1357. doi: 10.1017/S0033291799002895

Field, A. (2009). *Discovering Statistics Using SPSS. 2nd Edn*. London: Sage Publications.

Furmark, T., Tillfors, M., Stattin, H., Ekselius, L., and Fredrikson, M. (2000). Social phobia subtypes in the general population revealed by cluster analysis. *Psychol. Med.* 30, 1335–1344. doi: 10.1017/S0033291799002615

Gallagher, M. W., Payne, L. A., White, K. S., Shear, K. M., Woods, S. W., Gorman, J. M., et al. (2013). Mechanisms of change in cognitive behavioral therapy for panic disorder: The unique effects of self-efficacy and anxiety sensitivity. *Behav. Res. Ther.* 51, 767–777. doi: 10.1016/j.brat.2013.09.001

Gill, A., Osborne, M., and McPherson, G. (2022). Sources of self-efficacy in class and studio music lessons. *Resin Music Educ.* 4, 1321103X.221123234. doi: 10.1177/1321103X221123234

Givertz, M., and Segrin, C. (2014). The association between overinvolved parenting and young adults' self-efficacy, psychological entitlement, and family communication. *Commun. Res.* 41, 1111–1136. doi: 10.1177/0093650212456392

Gonzalez Diez, Z., Calvete Zumalde, E., and Orue Sola, I. (2012). Early maladaptive schemas and social anxiety; The moderating effect of avoidant vs. overcompensation coping. *Eur. Psychiatry* 27, 1. doi: 10.1016/S0924-9338(12)74296-7

Gould, D., Lauer, L., Rolo, C., Jannes, C., and Pennisi, N. (2006). Understanding the role parents play in tennis success: a national survey of junior tennis coaches. *Br. J. Sports Med.* 40, 632–636. doi: 10.1136/bjsm.2005.024927

Harris, A. E., and Curtin, L. (2002). Parental perceptions, early maladaptive schemas, and depressive symptoms in young adults. *Cognit. Ther. Res.* 26, 405–416. doi: 10.1023/A:1016085112981

Haugh, J. A., Miceli, M., and DeLorme, J. (2017). Maladaptive parenting, temperament, early maladaptive schemas, and depression: a moderated mediation analysis. *J. Psychopathol. Behav. Assessment* 39, 103–116. doi: 10.1007/s10862-016-9559-5

Hawke, L. D., and Provencher, M. D. (2012). The Canadian French Young schema questionnaire: confirmatory factor analysis and validation in clinical and non-clinical samples. *Can. J. Behav. Sci.* 44, 40–49. doi: 10.1037/a0026197

Heinrichs, N., and Hofmann, S. G. (2001). Information processing in social phobia: a critical review. *Clin. Psychol. Rev.* 21, 751–770. doi: 10.1016/S0272-7358(00)00067-2

Hudson, J. L., and Rapee, R. M. (2000). The origins of social phobia. *Behav. Modif.* 24, 102–129. doi: 10.1177/0145445500241006

Huston, J. L. (2001). *Familial antecedents of musical performance anxiety: A comparison with social anxiety. Dissertation Abstracts International: Section B: the Sciences and Engineering, 62, 551. (Accession No. MRB-FSD*0336854)

Iusca, D., and Dafinoiu, I. (2012). Performance anxiety and musical level of undergraduate students in exam situations: the role of gender and musical instrument. *Proce. Soc. Behav. Sci.* 33, 448–452. doi: 10.1016/j.sbspro.2012.01.161

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T. (2011). *The Psychology of Music Performance Anxiety*. Oxford: Oxford University Press.

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Dis.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kenny, D. T., Fortune, J. M., and Ackermann, B. (2011). Predictors of music performance anxiety during skilled performance in tertiary flute players. *Psychol. Music* 41, 306–328. doi: 10.1177/0305735611425904

Kenny, D. T., and Osborne, M. S. (2006). Music performance anxiety: New insights from young musicians. *Adv. Cognit. Psychol.* 2, 103–112. doi: 10.2478/v10053-008-0049-5

Kriston, L., Schäfer, J., Jacob, G. A., Härter, M., and Hölzel, L. P. (2013). Reliability and validity of the german version of the young schema questionnaire – short form 3 (YSQ-S3). *Eur. J. Psychol. Assessment* 29, 205–212. doi: 10.1027/1015-5759/a000143

Lockwood, G., and Perris, P. (2012). "A new look at core emotional needs," in *The Wiley-Blackwell Handbook of Schema Therapy: Theory, Research, and Practice*, eds M. van Vreeswijk, J. Broersen, and M. Nardort (New York, NY: John Wiley and Sons), 58-72.

Lumley, M. N., and Harkness, K. L. (2007). Specificity among the relations in childhood adversity, early maladaptive schemas, and symptom profiles in adolescent depression. *Cognit. Ther. Res.* 31, 639–657. doi: 10.1007/s10608-006-9100-3

McGinn, L. K., Cukor, D., and Sanderson, W. C. (2005). The relationship between parenting style, cognitive style, and anxiety and depression: does increased early adversity influence symptom severity through the mediating role of cognitive style? *Cognit. Ther. Res.* 29, 219–242. doi: 10.1007/s10608-005-3166-1

McLeod, B. D., Wood, J. J., and Weisz, J. R. (2007). Examining the association between parenting and childhood anxiety: a meta-analysis. *Clin. Psychol. Rev.* 27, 155–172. doi: 10.1016/j.cpr.2006.09.002

McPherson, G. E. (2009). The role of parents in children's musical development. *Psychology of Music,* 37, 91–110. doi: 10.1177/0305735607086049

McPherson, G. E., and Davidson, J. W. (2002). Musical practice: mother and child interactions during the first year of learning an instrument. *Music Educ. Res.* 4, 141–156. doi: 10.1080/14613800220119822

McPherson, G. E., Davidson, J. W., and Faulkner, R. (2012). *Music in Our Lives: Rethinking Musical Development, Ability and Identity*. Oxford: Oxford University Press.

Mor, S., Day, H. I., and Flett, G. L., and Hewitt, P. L. (1995). Perfectionism, control, and components of performance anxiety in professional artists. *Cognit. Ther. Res.* 19, 207–225. doi: 10.1007/BF02229695

Neal, J. A., and Edelmann, R. J. (2003). The etiology of social phobia: toward a developmental profile. *Clin. Psychol. Rev.* 23, 761–786. doi: 10.1016/S0272-7358(03)00076-X

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., Rodríguez-Ledo, C., and Mazas, B. (2017). The relation of music performance anxiety (MPA) to optimism, self-efficacy, and sensitivity to reward and punishment: testing barlow's theory of personal vulnerability on a sample of spanish music students. *Psychol. Music* 45, 570–583. doi: 10.1177/0305735616674791

Osborne, J. W. (2010). Improving your data transformations: Applying the Box-Cox transformation. *Prac. Assess. Res. Eval.* 15, 1–7. doi: 10.7275/qbpc-gk17

Osborne, M. S. (2015). "Building performance confidence," in The Child as Musician: A Handbook of Musical Development, ed G. E. McPherson (Oxford: Oxford University Press), 422-440. doi: 10.1093/acprof:oso/9780198744443.003.0023

Osborne, M. S., and Franklin, J. (2002). Cognitive processes in music performance anxiety. *Austr. J. Psychol.* 54, 86–93. doi: 10.1080/00049530210001706543

Osborne, M. S., and Kenny, D. T. (2005). Development and validation of a music performance anxiety inventory for gifted adolescent musicians. *J. Anxiety Disorders* 19, 725–751. doi: 10.1016/j.janxdis.2004.09.002

Osborne, M. S., and Kenny, D. T. (2008). The role of sensitizing experiences in music performance anxiety in adolescent musicians. *Psychol. Music* 36, 447–462. doi: 10.1177/0305735607086051

Osborne, M. S., and Kirsner, J. (2022). *Music performance anxiety. Oxford Handbook of Music Performance.* Oxford: Oxford University Press. doi: 10.1093/oxfordhb/9780190058869.013.11

Parker, G. (1979). Reported parental characteristics of agoraphobics and social phobics. *British Journal of Psychiatry* 135, 555–560. doi: 10.1192/bjp.135.6.555

Parker, G., Tupling, H., and Brown, L. B. (1979). A parental bonding instrument. *Br. J. Med. Psychol.* 52, 1–10. doi: 10.1111/j.2044-8341.1979.tb02487.x

Patston, T., and Osborne, M. S. (2016). The developmental features of music performance anxiety and perfectionism in school age music students. *Perf. Enhancement Health* 4, 42–49. doi: 10.1016/j.peh.2015.09.003

Peeters, N., Stappenbelt, S., Burk, W. J., van Passel, B., and Krans, J. (2021). Schema therapy with exposure and response prevention for the treatment of chronic anxiety with comorbid personality disorder. *Br. J. Clin. Psychol.* 60, 68–76. doi: 10.1111/bjc.12271

Pietkiewicz, I., and Smith, J. A. (2014). A practical guide to using interpretative phenomenological analysis in qualitative research psychology. *Psychol. J.* 20, 7–14. doi: 10.14691/CPPJ.20.1.7

Pinto-Gouveia, J., Castilho, P., Galhardo, A., and Cuhna, M. (2006). Early maladaptive schemas and social phobia. *Cognit. Ther. Res.* 30, 571–584. doi: 10.1007/s10608-006-9027-8

Rapee, R. M. (1997). Potential role of childrearing practices in the development of anxiety and depression. *Clin. Psychol. Rev.* 17, 47–67. doi: 10.1016/S0272-7358(96)00040-2

Rapee, R. M., and Melville, L. F. (1997). Recall of family factors in social phobia and panic disorder: Comparison of mother and offspring reports. *Depression and Anxiety* 5, 7–11. doi: 10.1002/(sici)1520-6394(1997)5:1<7::aid-da2>3.0.co;2-e

Robson, K. E., and Kenny, D. T. (2017). Music performance anxiety in ensemble rehearsals and concerts: A comparison of music and non-music major undergraduate students. *Psychol. Music* 45, 868–885. doi: 10.1177/0305735617693472

Ryan, R. M., and Deci, E. L. (2002). Overview of Self-Determination Theory: An Organismic-Dialectical Perspective. Handbook of Self-Determination Research (Rochester: University of Rochester Press), 3–33.

Saariaho, T., Saariaho, A., Karila, I., and Joukamaa, M. (2009). The psychometric properties of the finnish young schema questionnaire in chronic pain patients and a non-clinical sample. *J. Behav. Ther. Exp. Psychiatry* 40, 158–168. doi: 10.1016/j.jbtep.2008.07.005

Sachs-Ericsson, N., Verona, E., Joiner, T., and Preacher, K. J. (2006). Parental verbal abuse and the mediating role of self-criticism in adult internalizing disorders. *J. Aff. Disorders* 93, 71–78. doi: 10.1016/j.jad.2006.02.014

Schimmenti, A., and Bifulco, A. (2015). Linking lack of care in childhood to anxiety disorders in emerging adulthood: the role of attachment styles. *Child Adolescent Mental Health* 20, 41–48. doi: 10.1111/camh.12051

Sempértegui, G. A., Karreman, A., Arntz, A., and Bekker, M. H. J. (2013). Schema therapy for borderline personality disorder: a comprehensive review of its clinical foundations, effectiveness and implementation possibilities. *Clin. Psychol. Review* 33, 426–447. doi: 10.1016/j.cpr.2012.11.006

Shah, R., and Waller, G. (2000). Parental style and vulnerability to depression: the role of core beliefs. *J. Nervous Mental Disease* 188, 19–25. doi: 10.1097/00005053-200001000-00004

Smith, A. J., and Rickard, N. S. (2004). Prediction of music performance anxiety via personality and trait anxiety in young musicians. *Austr. J. Music Education* 1, 3–12.

Steptoe, A., and Fidler, H. (1987). Stage fright in orchestral musicians: a study of cognitive and behavioural strategies in performance anxiety. *Br. J. Psychol.* 78, 241–249. doi: 10.1111/j.2044-8295.1987.tb02243.x

Stopa, L., and Clark, D. M. (2001). Social phobia: comments on the viability and validity of an analogue research strategy and british norms for the fear of negative evaluation questionnaire. *Behav. Cognit. Psychother.* 29, 423–430. doi: 10.1017/S1352465801004039

Straarup, N. S., Renneberg, H. B., Farrell, J., and Younan, R. (2022). Group schema therapy for patients with severe anxiety disorders. *Journal of Clinical Psychology* 78, 1–11. doi: 10.1002/jclp.23351

Teicher, M. H., Samson, J. A., Polcari, A., and McGreenery, C. E. (2006). Sticks, stones, and hurtful words: relative effects of various forms of childhood maltreatment. *Am. J. Psychiatry* 163, 993–1000. doi: 10.1176/ajp.2006.163.6.993

van der Bruggen, C. O., Stams, G. J. J. M., and Bögels, S. M. (2008). Research review: the relation between child and parent anxiety and parental control: a meta-analytic review. *J. Child Psychol. Psychiatry* 49, 1257–1269. doi: 10.1111/j.1469-7610.2008.01898.x

van Genderen, H., Rijkeboer, M., and Arntz, A. (2012). *Theoretical Models: Schemas, Coping Styles, and Modes The Wiley-Blackwell Handbook of schema Therapy: Theory, Research, and Practice.* London: John Wiley and Sons. doi: 10.1002/9781119962830.ch2

van Vlierberghe, L., Braet, C., Bosmans, G., Rosseel, Y., and Bögels, S. (2010). Maladaptive schemas and psychopathology in adolescence: On the utility of Young's schema theory in youth. *Cognit. Ther. Res.* 34, 316–332. doi: 10.1007/s10608-009-9283-5

van Vreeswijk, M. F., Spinhoven, P., Eurelings-Bontekoe, E. H. M., and Broersen, J. (2014). Changes in symptoms severity, schemas and modes in heterogeneous psychiatric patient groups following short-term schema cognitive behavioural group therapy: a naturalistic pre-treatment and post-treatment design in an outpatient clinic. *Clin. Psychol. Psychotherapy* 21, 29–38. doi: 10.1002/cpp.1813

Weeks, J. W., Heimberg, R. G., Fresco, D. M., Hart, T. A., Turk, C. L., Liebowitz, M. R., et al. (2005). Empirical validation and psychometric evaluation of the brief fear of negative evaluation scale in patients with social anxiety disorder. *Psychol. Assessment* 17, 179–190. doi: 10.1037/1040-3590.17.2.179

Welburn, K., Coristine, M., Dagg, P., Pontefract, A., and Jordan, S. (2002). The schema questionnaire-short form: Factor analysis and relationship between schemas and symptoms. *Cognit. Ther. Res.* 26, 519–530. doi: 10.1023/A:1016231902020

Wesner, R. B., Noyes, R., and Davis, T. L. (1990). The occurrence of music performance anxiety among musicians. *J. Aff. Disorders* 18, 177–185. doi: 10.1016/0165-0327(90)90034-6

Young, J. E. (1999). *Cognitive Therapy for Personality Disorders: A Schema-Focused Approach*. New York, NY: Professional Resources Press.

Young, J. E. (2005). *Young Schema Questionnaire Short Form*. London: Schema Therapy Institute.

Young, J. E. (2014). *Young Parenting Inventory*. (YPI). London: Schema Therapy Institute.

Young, J. E., Klosko, J. S., and Weishaar, M. E. (2003). *Schema Therapy: A Practitioner's Guide*. New York, NY: Guilford Press.

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Dispositional and performance-specific music performance anxiety in young amateur musicians

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Introduction: Research on Music Performance Anxiety (MPA) among amateur musicians is of great interest due to inconsistent results in literature. In addition, amateur music represents an important part of musical culture in Germany. Accordingly, the performance experiences of young wind players represent a relevant issue for research and musical practice.

Methods: In the present study, 67 young amateur musicians of a brass choir were examined. Using two different questionnaires, both the dispositional MPA (K-MPAI) and the performance-specific MPA during a joint concert (Performance-specific Questionnaire for Musicians, PQM) were assessed. The PQM measures the symptoms of MPA, functional coping with MPA and self-efficacy before, during and after a specific performance. The PQM was completed by the musicians *via* an app directly after the concert.

Results: Results showed that about 90% of the young amateur musicians had a low dispositional MPA, but about 10% showed high values. For the concrete performance, however, musicians with high dispositional MPA also experienced a very moderate to low MPA in the concert. On average, the musicians were quite nervous before the performance. After the performance, they showed low levels of MPA. Three types of MPA found in previous studies could be confirmed among the amateur musicians, with three quarters being assigned to the positive type, showing low levels of symptoms associated with consistently high levels of self-efficacy and positive functional coping.

Discussion: The results provide a differentiated picture of different expressions of MPA in young amateur musicians. They also raise further questions about the correlation between dispositional and performance-specific assessment of MPA in musicians in general.

KEYWORDS

performance science, music performance anxiety, self-efficacy, coping, performance quality, amateur musicians

1. Introduction

Music Performance Anxiety (MPA) is a phenomenon that manifests itself in musicians exposing themselves in front of an audience (Spahn, 2012, 2015). MPA is generally described as a state of excitement, which can bring a variety of negative symptoms of stress reaction (Fernholz et al., 2019; Guyon et al., 2020), but can in its optimal level also enhance a performance. Factors

concerning the degree of occurring MPA were identified as the size or composition of the audience, the level of demand, and the assessment of the relevance of the performance (Le Blanc et al., 1997; Spahn, 2012; Zimmermann and Louven, 2017; Osborne and Kirsner, 2022). High levels of MPA can lead to chronically debilitating impacts on future performance experiences (Kenny and Osborne, 2006).

Self-efficacy can play a key role in dealing with MPA. A study by McCormick and McPherson suggests that a high level of self-efficacy is a strong predictor of a positive performance experience (McCormick and McPherson, 2003). In a study with 270 Spanish musicians, González et al. (2018) showed that self-efficacy correlated positively with self-reported experiences of performances.

1.1. MPA in amateur and professional musicians

Musicians might react differently based on their professional level, with professionals experiencing higher levels of MPA (Osborne and Kenny, 2005). In a sample of 100 musicians (half professionals and half amateurs), the professional musicians showed higher MPA compared to amateur musicians (Castiglionea et al., 2018). In contrast, among Brazilian musicians, professional and amateur musicians seemed to have similar levels of MPA, but the professional musicians showed higher levels of general social anxiety (Barbar et al., 2014). Papageorgi et al. (2013) reported higher levels of MPA in undergraduate musicians than in professionals, interpretating that more performing experience among the professionals might affect the degree of MPA. A study by Sickert et al. (2022) also showed lower mean MPA scores (K-MPAI-R) among professionals compared to amateurs and music students, with the latter having the highest mean scores.

Overall, different study results are found when comparing MPA in professional and amateur musicians. The survey of MPA in different samples, in particular among amateur musicians, therefore seems worthwhile for further research.

1.2. MPA in young musicians

MPA in the context of musical performance can be observed throughout childhood and adolescence (Kenny and Osborne, 2006; Patston and Osborne, 2016; Dempsey and Comeau, 2019; Dobos et al., 2019; Barros et al., 2022). It affects up to one-third of musicians during adolescence (Fehm and Schmidt, 2006) and peaks at age fifteen, with less MPA reported with increasing frequency of performance (Osborne and Kenny, 2005). In a sample of 239 students at German music schools between the ages of 7 and 20, it was also observed that MPA increased significantly at ages 13–15 (Spahn, 2011; Nusseck et al., 2015). Papageorgi (2022) found that MPA in adolescents increased between the ages of 15 and 18, and decreased at the age of 19.

Furthermore, a study examining MPA in young musicians found that those who wanted to make music their profession had less MPA than those who could not imagine it or did not yet know it (Osborne and Kenny, 2005). With increasing age, young musicians begin to perceive themselves and their environment in a more differentiated way, so that they learn to deal with their own insecurity during a performance, however, their attitude of entitlement toward musical performances also increases in the course of adolescence (Kenny and Osborne, 2006). Correlations of higher degrees of MPA in young musicians were found with lower self-confidence and with lower performance quality (Ryan, 2005). Young musicians (aged 7–17 years) often reported a worsening of the performance quality in public performances compared to practice situations (Sokoli et al., 2022).

Other findings revealed a statistically significant negative correlation between MPA and music performance self-efficacy in adolescent musicians (Bersh, 2022). For 16-18-year-olds, self-efficacy was related to the experience of public performances, whereas social support was found to be less correlated with self-efficacy (Orejudo et al., 2021). A strong negative relationship between self-efficacy and MPA was also found by Dempsey and Comeau (2019) in young musicians.

In a sample of 410 young classical musicians in Cyprus and the United Kingdom attending junior conservatoires and/or youth orchestras with ages ranged between 12 and 19 years and a mean of 15.33 years, Papageorgi (2021) performed a cluster analysis on the values of MPA. The analysis revealed three types of MPA with (Cluster 1) moderate anxiety, less intrinsic motivation for learning and low self-efficacy, with (Cluster 2) high anxiety, high MPA and low self-efficacy, and with (Cluster 3) less anxiety, high motivations and high self-confidence. 11% of the musicians experienced high levels of MPA, where 20% were in the low MPA and 69% in the average MPA cluster. Approximately 60% of the cluster variance was explained by individual characteristics such as the susceptibility to anxiety, task-efficacy, and the performance environment.

1.3. Dispositional and performance-specific MPA

The understanding of MPA in the field of research primarily refers to the form of MPA as measured by Kenny's questionnaire (K-MPAI, Kenny, 2009, 2011). The experience of MPA here means a person's average experience of MPA over an extended period of time. In distinction to this form – for which we propose the term dispositional MPA – MPA can be surveyed with respect to a specific performance – the so-called performance-specific MPA. Other authors also recommend to differentiate between the dispositional level of MPA as a trait component and the occurrence in a concrete performance situation (Papageorgi et al., 2007) and to investigate how the relationship between MPA and self-efficacy is affected in concrete performances (Bersh, 2022).

Trait anxiety was strongly associated with a higher degree of dispositional MPA (Kenny et al., 2004; Papageorgi et al., 2007). Musicians with high levels of dispositional MPA also showed to have higher state anxiety, psychological distress and negative self-assessments compared to musicians with low dispositional MPA levels (Studer et al., 2012; Guyon et al., 2020). However, in a questionnaire survey of 320 professional and student musicians, the dispositional MPA was not a clear indicator for experienced distress, but can also influence perceived performance boosts and confidence (Simoens et al., 2015).

Investigating a concrete performance situation, the Performance-specific Questionnaire for Musicians (PQM, Spahn et al., 2016)

considering the experience of MPA at the time directly before a performance, during a performance and after a performance has been developed. The questionnaire needs to be filled in immediately after a performance and addresses three aspects of MPA, i.e., occurring symptoms of MPA, the functional coping with MPA and the self-efficacy for each time point. In a sample of 532 musicians including professional orchestra musicians, amateur orchestra musicians and amateur choir singers, three different types of performance-specific MPA were found (Spahn et al., 2021). Musicians of Type 1 had few symptoms of MPA, high functional coping with MPA and high self-efficacy throughout the performance, indicating healthy and good experiences of the performance. Type 2 describes musicians who began the performance with relatively high symptoms of MPA that reduced after the performance. They also showed rather high values in functional coping and self-efficacy. The musicians in Type 3 did experience the performance in a more unpleasant way. They began their performance with more symptoms of MPA than in the other types. After the performance, those symptoms of MPA even slightly increased. The values of functional coping and self-efficacy were also lower than in the other types. Nearly half of the musicians were classified in Type 1 and about a quarter each to Type 2 and 3. It was found, that amateur musicians in the sample were more often distributed in Type 1 and 2 whereas professional musicians in Type 3. In addition, self-efficacy seemed to have an important influence on the other two scales and therewith on the experience of the performance.

Papageorgi (2021) formed clusters regarding anxiety, motivation, and self-esteem in the sample of 410 adolescent musicians described in Papageorgi (2022). She also found three clusters, each covering one-third of the sample:

Cluster 1 – moderately anxious students who show lower levels of motivation and feel ineffective, but maintain their self-esteem; experience of physiological symptoms of anxiety, suggesting that they experienced moderate arousal levels.

Cluster 2 – highly anxious students who have a negative self-image and are prone to maladaptive MPA;

Cluster 3 – low anxious students who have a high level of motivation and self-confidence and are prone to adaptive MPA.

Regarding this description, similarities can be found between the clusters in Papageorgi (2021) and the types in Spahn et al. (2021). Thus, musicians in cluster 1 according to Papageorgi show similarities to musicians in type 2 according to Spahn et al., those in cluster 2 to those in type 3, and musicians in cluster 3 to those in type 1.

1.4. The current study

In the present study, MPA was investigated in young amateur musicians of two brass choirs. The relevance of the study can be seen in the following points. In view of the studies presented above, the investigation of MPA in young musicians and especially in young amateur musicians seems interesting. Furthermore, in the present study, our research group wanted to extend the previously collected results on performance-specific MPA, collect them on a homogeneous sample of amateur musicians, and make direct comparisons with dispositional MPA.

In addition, young amateur brass players represent a significant group in the musical culture in Germany. 19% of the German population make music in their free time, i.e., there are 14 million amateur musicians. Among the 16–29 years olds, the share is 32%. In southern Germany in particular, there is a traditional and well-established structure of music clubs in which wind instruments are very strongly represented (MIZ 2021[1]). The Bund Deutscher Blasmusikverbände e.V., for example, has 1,000 member clubs and 200,000 amateur musicians[2]. Young wind players in amateur music therefore make up an important part.

To our knowledge, there are only a few studies about the MPA state of brass musicians. These studies investigated MPA in brass players in professional orchestras and found an increased MPA compared to other instrumentalists (Fishbein and Middlestadt, 1988; Cohen and Bodner, 2021). The authors justify their results in relation to the soloistic and playing technique demands in the orchestra. However, these demands are hardly comparable to those of amateur musicians in a brass ensemble.

Moreover, Kenny (2011) did not find any instruction-specific correlation with the development of MPA in her study. Regarding the actual research situation concerning the spectrum and coping with MPA among young musicians, we can summarize that there are many studies examining influences of different social and individual factors on MPA of music students (see also Barros et al., 2022). However, the results about the relationship of age, experience and MPA are not consistent, especially associations between different expertise factors and MPA require further clarification. One reason for that could be the lack of studies investigating MPA of music activities in the leisure sector.

Therefore, this study aims at exploratory investigating the dispositional and performance-specific music performance anxiety of amateur musicians in the context of a joint performance of a brass choir. More specific, we study the performance-specific MPA by comparing and relating current scores with other participant groups, research settings and measures of dispositional MPA. We assume, that these exploratory findings contribute to the discourse of MPA among amateur musicians and introduce some new methodological aspects of interest for the field.

2. Methods

2.1. Study design

The study involved two groups of musicians in two youth brass choirs. The musicians of each group participated in two big-band weekend workshops each with a joint concert at the end of the weekend. All the musicians were provided with information about the study in advance and at the beginning of the workshop. In order to participate in the study, it was required to sign a consent form. For underage participants, informed consent was obtained from their legal guardians. The ethics committee of the University of Freiburg gave a positive vote for the conduct of this study.

Two surveys took place at two points in time. At the beginning of the first weekend workshop, the participants were asked to answer sociodemographic (age, gender) and music-related

1 https://miz.org/de/dokumente/musikindustrie-in-zahlen-2021

2 https://www.bdb-akademie.com/verband/mitglieder/

(instrument, years of instrumental training) questions and to fill in a first standardized questionnaire about their individual disposition in experiencing MPA. After the joint concert at the end of the second weekend workshop, participants were asked to complete a second standardized questionnaire regarding the experience of MPA related to the just finished performance. The first questionnaire was provided in paper form. The second questionnaire was filled in directly after the concerts and was presented as a smartphone app that the participants either installed on their own device or used on someone else's device.

2.2. Participants

A total of 67 musicians participated in the study. In the first group were 32 musicians, in the second group 35 musicians. The instruments amounted to 43% trombone, 43% trumpet, 9% horn and 5% tuba. Regarding gender distribution, age and years of instrumental training, there were no significant differences between the two groups. Therefore, the participants of both groups were combined into one sample. In this sample ($n = 67$) the percentage of female musicians was 58%. On average, participants trained their instrument for 9.5 years (range: 5–17 years, SD = 2.86 years).

The mean age of the musicians was 18.5 years (SD = 3.03 years). The range was 13–26 years. The age amounted to 17% 13–15 years, 36% 16–18 years, 36% 19–22 years and 11% over 22 years. This shows a rather normal distribution across the age groups.

After the joint concerts, 58 musicians filled in the second questionnaire. As well as in the sample of 67 musicians, there were still no significant differences between the two groups.

2.3. Questionnaires

2.3.1. Kenny-music performance anxiety inventory (K-MPAI)

Because of the age range of the sample between 13 and 26 years, the adult version of the K-MPAI was chosen instead of the version for use with child and adolescent musicians (Osborne and Kenny, 2005). The Kenny-Music Performance Anxiety Inventory (K-MPAI, Kenny, 2009, 2011) is a standardized questionnaire to determine the dispositional degree of MPA. The revised version has 40 items answered on a 7-point Likert scale ranging from 0 = "do not agree" to 6 = "fully agree." The total scale was used that showed high internal reliability (Cronbach's alpha = 0.94; Kenny, 2009). A higher score represents higher levels of MPA as well as psychological distress (Kenny, 2011). The questionnaire has been validated and used in numerous research studies and is available in several languages (Kenny, 2023).

The K-MPAI scale ranges between 0 and 240. In a sample of 373 professional orchestra musicians, a mean value of 83.7 (SD = 40.7) was found (Kenny et al., 2012). Using this sample, a comparative analysis with other established clinical screening tests of anxiety and depression was performed to indicate possible cut-off values for high degrees of MPA (Kenny, 2015). The findings suggested a high level of MPA above 104. In the present study, a translated German version of the questionnaire was used and showed a high internal reliability (Cronbach's alpha = 0.89; $n = 67$).

2.3.2. Performance-specific questionnaire for musicians (PQM)

To measure self-reported MPA considering a particular performance, the Performance-specific Questionnaire for Musicians (PQM, Spahn et al., 2016) was used. The questionnaire requires to be filled in immediately following a performance. It contains a total of 42 items with the first 32 questions addressing retrospectively the times before, during, and after the performance. For each time of the performance, three aspects of MPA were assessed: (1) the functional coping with MPA, i.e., positive activities in handling with MPA (Cronbach's alpha: before 0.73, during 0.80, after 0.66, $n = 58$), (2) symptoms of MPA (Cronbach's alpha: before 0.81, during 0.83, after 0.67, $n = 58$), and (3) self-efficacy, i.e., one's own confidence in performing (Cronbach's alpha: before 0.71, during 0.77, after 0.83, $n = 58$). For the three scales, similar items were used across the different performance times with the prefaces "A few minutes before the performance…," "During the performance…" and "Now, after the performance…." Examples of items are for the functional coping "… I could concentrate on my musical performance," for the symptoms of MPA "… I thought about all the things that could go wrong" and for the self-efficacy "… I could imagine the audience enjoying my performance." The questions were answered on a 5-point Likert scale (1 = "does not apply" to 5 = "applies very much"). High values in the scales functional coping and self-efficacy indicate better coping and higher self-efficacy whereas high scores in the scale symptoms of MPA give notice of debilitating MPA.

An additional scale with seven items evaluates the self-perceived musical quality of the performance (Cronbach's alpha = 0.77, $n = 58$). The music-related aspects were rated on a 6-point scale ranging from 1 = "very poor" to 6 = "excellent."

Specific personal aspects of the performance were queried with three further items. The participants were asked to state the personal importance of the performance on a 4-point scale (1 = "not important" to 4 = "very important"). In another question, the musicians were asked to rate the difficulty of the performance compared to other performances on a 4-point scale (1 = "easy" to 4 = "difficult"). Finally, the general personal difficulty of the concert was assessed on a 5-point scale (1 = "too low" to 5 = "too high").

2.4. Statistics

The analyses were carried out with SPSS 28 (Armonk, NY: IBM Corp). Descriptive statistics include the mean value and the standard deviation (SD) of the mean. A hierarchical cluster analysis (Method: single-linkage between groups; Squared Euclidean Distance) was performed on the K-MPAI scale. With the cluster solution, a k-mean cluster analysis was performed.

To classify the different types of MPA according to Spahn et al. (2021), a k-mean cluster analyses with three clusters were performed with the PQM scales regarding the time before the performance. The percentage of explained variance was calculated with a discriminate analysis. Multivariate analysis of variance (MANOVA) was used for the comparative analysis of the questionnaire scales. On significance, post-hoc analyzes were performed using the Tukey-HSD correction.

Independent t-tests were used for individual comparisons. Nonparametric comparisons were examined using a cross table

reporting Pearson's χ^2. Significant Pearson's r correlation coefficients were categorized as followed: $r < 0.3$: weak to no correlation, $r > 0.3$ and < 0.5: moderate correlation, $r > 0$ 0.5: strong correlation (Cohen, 1988). The level of significance was set to $p = 0.05$.

3. Results

3.1. Dispositional MPA

3.1.1. Descriptive results of the K-MPAI

In the K-MPAI, measuring the dispositional MPA, the mean value of the whole sample was 85.3 (SD = 27.5). The value did not differ significantly from the mean value of the orchestra musicians (t(57) < 1.0; Kenny et al., 2012) and it was significantly below the cut-off for high degrees of MPA at 104, found by Kenny (2015) in professional orchestra musicians [$t(57) = -5.18$; $p < 0.001$].

Female musicians scored slightly higher (89.5; SD = 25.4) than male musicians (78.9, SD 29.7), but without statistical significance [$F(1,56) = 2.1$; n.s.]. The K-MPAI scale did not correlate significantly with age ($r = 0.07$) nor with the years of instrumental training ($r = 0.08$).

3.1.2. Cluster analysis on the K-MPAI

The cluster analysis on the K-MPAI yielded a three groups solution with a 92% explained variance. One group of 26 musicians (45%) showed quite low K-MPAI values (60.9; SD = 10.1), a second group of 18 musicians (31%) showed medium K-MPAI values (80.4; SD = 7.9), and a third group of 14 musicians (24%) had high K-MPAI values (124.1; SD = 13.3). These groups did not differ significantly in gender, age and years of instrumental training. While the mean values of the first two groups were significantly below the cut-off of 104 ($p < 0.001$), the value of the third group was significantly above this cut-off ($p < 0.001$).

3.2. Performance-specific MPA

3.2.1. Descriptive results of the PQM

The results of the PQM refer to the joint performances of the brass choirs. The scales of the PQM assess symptoms of MPA, functional coping and self-efficacy before, during and after the performance (Table 1).

Overall, the results of the PQM scales show that the musicians had a high functional coping with MPA and a high self-efficacy. In the scale symptoms of MPA, the musicians tended to have rather high values before and during the performance, which decreased significantly to a low level after the performance [$F(1,57) = 14.8$; $p < 0.001$; Post-Hoc: before/during to after: $p < 0.001$]. In the course of the performance, functional coping was high before, decreased during the performance and increased significantly again after the performance [$F(1,57) = 4.75$; $p = 0.033$; Post-Hoc: during to after: $p = 0.010$]. The self-efficacy scale did not change significantly across the performance.

3.2.2. Classification of types of MPA

Regarding the course of the PQM scales over the performance, the k-mean classification of participants with three clusters according to Spahn et al. (2021) resulted in a distribution of 42 musicians (72%) in Type 1, eight musicians (14%) in Type 2, and eight musicians (14%) in Type 3 (Figure 1).

Compared with the mean scores of the PQM scales of the three Types in Spahn et al. (2021), the symptoms of MPA scales before and during performance were higher in *Type 1* in this study. After the performance, the values have adjusted to a similar low level as in Spahn et al. (2021).

In Type 2, the course of the PQM scales was rather comparable to Spahn et al. (2021), with significant increasing functional coping over the performance [Friedman-Test; $\chi^2(8,2) = 7.52$; $p = 0.023$] and rather high symptoms of MPA before the performance that significantly decrease after the performance [Friedman-Test; $\chi^2(8,2) = 13.0$; $p = 0.002$]. However, the values in the functional coping before and during the performance were much lower and the symptoms of MPA were much higher in this study.

The low score in the self-efficacy in *Type 3* was similar to Spahn et al. (2021). In contrast to the increase of the symptoms of MPA after the performance of Type 3 in Spahn et al. (2021), the mean value remained the same here [Friedman-Test; $\chi^2(8,2) = 1.36$; n.s.] and was at a similar level of the other two Types.

3.2.3. Comparison of MPA type classifications

The shown classification of the MPA types were performed with the distribution parameters of the discriminant analysis in Spahn et al. (2021). When performing a separated k-mean clustering on this sample, very similar properties of each cluster according to the types in Spahn et al. (2021) were found. The comparison between the two MPA type classifications showed 82% agreement. Therefore, the type distribution according to Spahn et al. (2021) was also reliable to this sample.

3.2.4. Self-rated quality, importance and difficulty of the performance

The quality of the performance was rated by the musicians with an average of 4.3 (SD = 0.5), which means – on a scale range of 1 to 6 – a rather good assessment. The importance of the performance was

TABLE 1 Mean values with standard deviations (SD) in the PQM scales (range 1–5) of the young amateur musicians ($n = 58$) with statistical analysis (repeated measure ANOVA).

	Before the performance	During the performance	After the performance	Statistics
Symptoms of MPA	2,3 (0,92)	2,3 (0,94)	1,6 (0,58)	$F(1,57) = 14.8$; $p < 0.001$
Functional coping	4,2 (0,76)	4,0 (0,83)	4,4 (0,58)	$F(1,57) = 4.75$; $p = 0.033$
Self-efficacy	4,0 (0,73)	4,1 (0,68)	4,0 (0,84)	$F(1,57) < 1.0$; n.s.

10.3389/fpsyg.2023.1208311

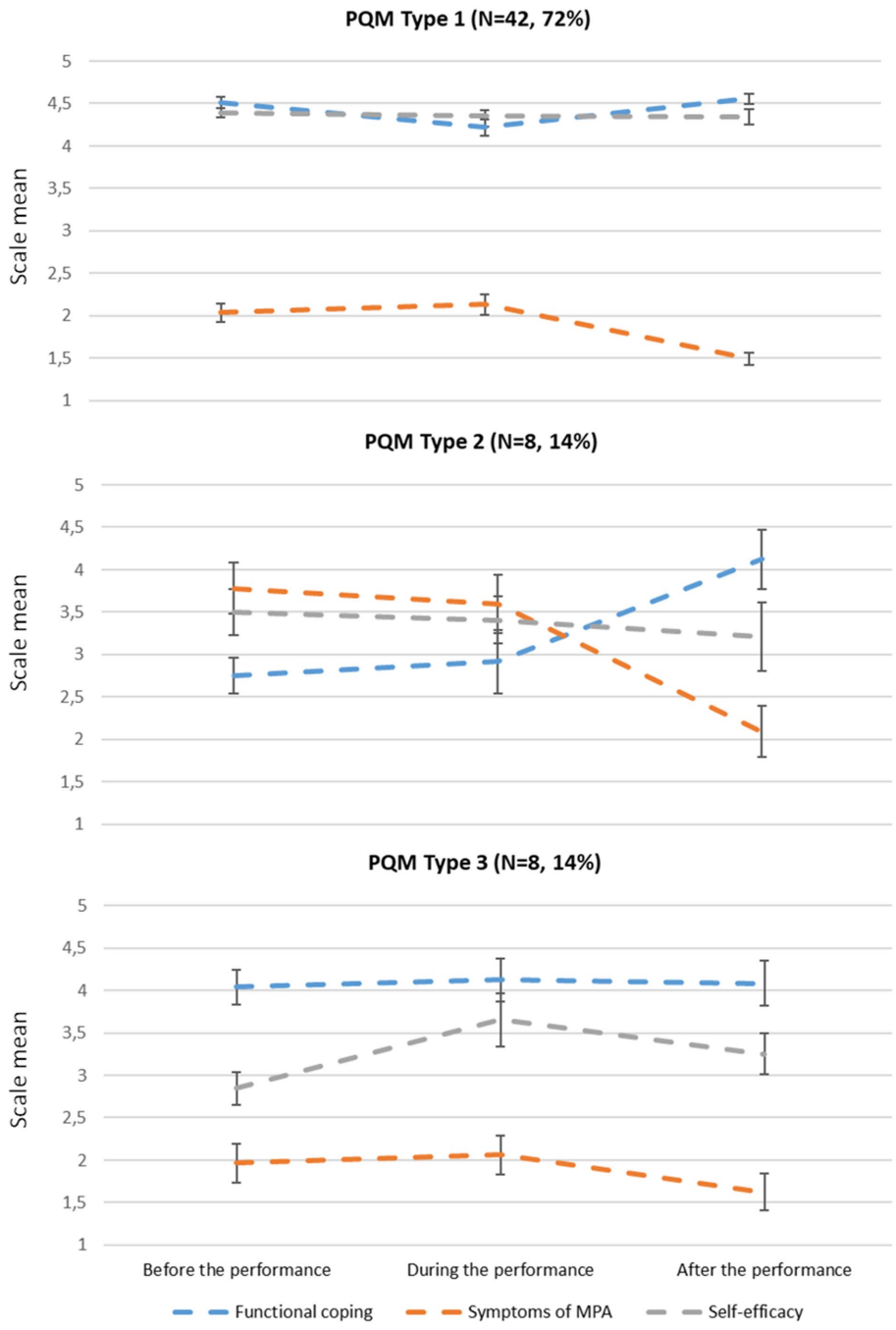

FIGURE 1
Mean values (error bars represent the standard error of the mean) in the PQM scales by PQM Type 1, 2 and 3 according to Spahn et al. (2021), among young amateur musicians ($n = 58$).

valued with 3.3 (SD = 0.7), describing the performance – on scale range of 1 to 4 – as a quite important one. The difficulty of the performance compared to other performances was judged to be just right (2.9; SD = 0.5; scale range of 1 to 5) and the general performance difficulty was experienced as easy but not too easy (2.1; SD = 0.7; scale range of 1 to 5).

There were significant correlations between the rated performance quality and the symptoms of MPA, with lower symptoms associated with higher ratings (before: $r = -0.38$, during: $r = -0.19$, after: $r = -0.33$) and the self-efficacy (before: $r = 0.39$, during: $r = 0.37$, after: $r = 0.34$). Another significant correlation was found between the rated performance quality and the importance of the performance ($r = 0.34$).

3.3. Relationship between dispositional and performance-specific MPA

A comparison between the three K-MPAI cluster groups and the PQM Types 1–3 revealed no significant difference in distribution [$\chi^2(57) = 6.48$; n.s.].

3.3.1. Correlations between K-MPAI and PQM values

Correlation analyses between the K-MPAI value of the total score and the PQM scales showed significant correlations with the symptoms of MPA scales before and after the performances, the functional coping scale after the performance, and the self-efficacy scales at all times of the performance (Table 2). No significant correlations were found for the importance of the performance, for the compared and general difficulty, and for the self-rated quality of the performance.

To investigate differences in the PQM scales between the three different groups of dispositional MPA, all PQM scales were compared between the three K-MPAI cluster groups (Table 2). The multivariate analysis showed significant differences in the self-efficacy scale before the performance between group 1 (low MPA) and group 3 (high MPA; $p = 0.015$), in the functional coping scale after the performance between group 1 and 3 ($p = 0.017$), and in the self-efficacy scale after the performance between group 1 and 3 ($p = 0.010$).

4. Discussion

In the present study, the results showed that about 90% of the young amateur musicians had a low dispositional MPA, but about 10% showed high values. For the concrete performance, however, musicians with high dispositional MPA also experienced a very moderate to low MPA in the concert. On average, the musicians were quite nervous before the performance. After the performance, they showed low levels of MPA. Three types of MPA found in previous studies could be confirmed among the amateur musicians, with three quarters being assigned to the positive type 1, showing low levels of symptoms associated with consistently high levels of self-efficacy and positive functional coping. In the following, we discuss the results on dispositional and performance-specific MPA and a relationship between the two in light of the existing literature.

4.1. Dispositional MPA in young amateur musicians

The young amateur musicians studied here showed, on average, a rather low dispositional MPA, which is below the cut-off of the K-MPAI established by Kenny. The values of professional orchestra musicians by Kenny (2015) were used as a comparison. The results are in agreement with those of Castiglionea et al. (2018), but different from Barbar et al. (2014) and Papageorgi et al. (2013), who found comparable or higher values for MPA in amateur musicians compared to professional musicians.

A direct comparison of the present results is provided by the study of Sickert et al. (2022), in which the K-MPAI was also used in amateur

TABLE 2 Correlations between the K-MPAI and the PQM scales (*$p < 0.05$; **$p < 0.01$) and mean values with standard deviation (SD) for the different PQM scales by K-MPAI cluster Groups 1, 2 and 3 with significant differences between the groups (bold, significant effects; n.s., not significant).

PQM	Correlations with the K-MPAI (total score)	Group 1 ($n = 26$) Low K-MPAI mean (SD)	Group 2 ($n = 18$) Medium K-MPAI mean (SD)	Group 3 ($n = 14$) High K-MPAI mean (SD)	Statistical difference between the Groups 1, 2 and 3
Importance of the performance	−0.13	3.4 (0.6)	3.2 (0.5)	3.1 (0.9)	n.s.
Compared difficulty	0.22	2.0 (0.7)	2.1 (0.8)	2.3 (0.7)	n.s.
General difficulty	0.13	2.9 (0.5)	3.1 (0.4)	2.9 (0.6)	n.s.
Quality of the performance	−0.16	4.3 (0.4)	4.4 (0.3)	4.2 (0.6)	n.s.
PQM scales					
Symptoms of MPA (before)	**0.26***	2.2 (0.7)	2.2 (1.1)	2.5 (0.9)	n.s.
Functional coping (before)	−0.15	4.3 (0.8)	4.1 (0.8)	4.2 (0.7)	n.s.
Self-efficacy (before)	**−0.39****	4.3 (0.5)	4.1 (0.6)	3.6 (0.9)	**$F(2,55) = 4.23$; $p = 0.019$**
Symptoms of MPA (during)	0.10	2.3 (0.9)	2.3 (0.9)	2.4 (1.0)	n.s.
Functional coping (during)	−0.06	4.0 (0.9)	4.0 (0.9)	4.1 (0.6)	n.s.
Self-efficacy (during)	**−0.30***	4.3 (0.6)	4.1 (0.6)	3.9 (0.6)	n.s.
Symptoms of MPA (after)	**0.34****	1.5 (0.5)	1.6 (0.5)	1.9 (0.7)	**$F(2,55) = 3.11$;** $p = 0.052$
Functional coping (after)	**−0.38****	4.7 (0.3)	4.3 (0.5)	4.2 (0.8)	**$F(2,55) = 5.06$; $p = 0.010$**
Self-efficacy (after)	**−0.42****	4.3 (0.6)	4.0 (0.8)	3.5 (1.0)	**$F(2,55) = 4.77$; $p = 0.012$**

musicians. In this German sample of 122 amateur musicians (age range: 19–71 years, mean 35.3 years, SD = 15.8 years), a mean value of 98.5 (SD = 40.9) was found (Sickert et al., 2022). The mean value in the present study is significantly lower at 85.3 (SD = 27.5; age range: 5–17 years, mean 9.5 years, SD = 2.86 years). Comparing the two studies, the different age structure of the samples is striking: in our study, there is a lower age range and a younger average age than in the study by Sickert et al. (2022). The extent to which these sample differences explain the differential MPA is difficult to interpret and should be the subject of further investigation.

The often found higher MPA in girls compared to boys (Osborne and Kirsner, 2022), was also seen in our sample, but did not become statistically significant. Similarly, no correlations were found between K-MPAI with age or years of instrumental training in consent with Dobos et al. (2019), but in opposite with other studies (Osborne and Kirsner, 2022). The results are difficult to include in this particular discussion. However, the findings may be caused due to the fact of the young age of the sample and the low variances in age and instrumental training.

To classify the large variance of dispositional MPA within the sample, a cluster analysis was performed on the K-MPAI scale. It yielded a clear solution of three different groups of the degree of MPA. The analysis found that about half of the young amateur musicians rated their MPA as quite low, about one third as medium and about a quarter of the musicians as high. The values for the latter group were significantly above the cut-off of Kenny (2015) in the K-MPAI.

The groups in our sample with low, medium, and high MPA did not differ significantly in gender, age, and years of instrumental training. Papageorgi (2022) was able to elucidate 60% of the variance in MPA by variables that related to individual characteristics such as high anxiety, task-efficacy, and the performance environment. In this context, the results of our study on MPA with regard to joint performance are particularly interesting, especially since here external influencing factors such as the musical task and the performance environment were the same for the musicians and thus person-related, individual factors must be the decisive influencing factors on the experience of MPA.

4.2. Performance-specific MPA in young amateur musicians

In our study, we had the opportunity to survey the course of MPA before, during, and after the final concert. The focus was on how strongly the musicians experienced the symptoms of MPA, how well they were able to cope with MPA and how high their self-efficacy was.

Regarding the joint concert, the musicians showed to have on average high functional coping and self-efficacy over the whole performance. However, they had rather high values in the symptoms of MPA scales before and during the performance. The symptoms of MPA decreased significantly to a low level after the performance.

Because the MPA symptoms did not correlate with age or years of instrumental training, they may be related to personal characteristics such as dispositional MPA. Interestingly, the K-MPAI total score showed a significant correlation with the symptoms of MPA after the performance, but only a weak, not significant correlation with the symptoms of MPA before and no relevant correlation with the symptoms of MPA during the performance. This leads to the assumption that the dispositional MPA seems not to be related with the performance specific MPA. This can be underlined by the findings the correlations with the performance quality scale. Since the K-MPAI is not correlated with the rated performance quality, the PQM scales were. This situational distress has more influence on the performance quality as the dispositional MPA.

4.2.1. Classification of types of MPA

Spahn et al. (2021) described three types of courses in terms of the interplay of symptoms of MPA, functional coping with MPA and self-efficacy related to a specific performance. In the present sample of amateur musicians, a similar cluster analysis was performed in order to compare the results with the typology by Spahn et al. (2021). The types 1, 2 and 3 are based on the different constellations of symptoms of MPA, functional coping with MPA and self-efficacy before the performance:

Musicians of *type 1* show low symptoms of MPA before the performance and high functional coping and self-efficacy at the same time. This initial constellation was shown by almost three-fourths of the amateur musicians in our sample, whereas only about half of the sample with professional and amateur musicians by Spahn et al. (2021) were of type 1. In the further course during and after the performance, the favorable constellation of symptoms of MPA, functional coping and self-efficacy is maintained in type 1, and symptoms of MPA are low after the performance. This was particularly the case for musicians in our sample. Thus, a favorable course persists in three-quarters of the amateur musicians belonging to type 1.

Type 2 musicians, in contrast to type 1, show high symptoms of MPA before performance, but also high self-efficacy at the same time. In our sample, functional coping was only moderate in type 2 musicians before the performance, but increased significantly until after the performance. According to the course of type 2, during and after the performance the symptoms of MPA decrease, which was significantly the case in our sample. Type 2 accounted for 14% of the amateur musicians in our sample.

Musicians of *type 3* show a rather low self-efficacy with moderate symptoms of MPA. In our sample, functional coping was strong among type 3 musicians. In the course, self-efficacy increased slightly until after the performance. In the musicians of type 3, a low value of symptoms of MPA was found in our sample with an overall positive constellation with self-efficacy and functional coping. Type 3 accounted for another 14% of the amateur musicians in our sample.

With regard to the different constellations before the performance, the three types found in the present sample of amateur musicians confirm the prescribed types by Spahn et al. (2021). What is striking in the present sample is the positive constellation present in all three types after the performance.

In comparison to the cluster analysis on young classical musicians of Papageorgi (2022), the classification in three MPA clusters was very similar. However, our sample contained twice as many young musicians with high dispositional MPA, but also more than twice as many with low MPA. Although the percentage distribution of low and high dispositional MPA differs between Papageorgis and our sample, we find that there is an interesting commonality of finding distinct subgroups in the expression of dispositional MPA among the adolescent and young amateur musicians. In our sample, which is rather homogeneous in terms of age, playing practice, and instrument,

this result appears to us as particularly remarkable. With regard to dispositional MPA, different individual prerequisites for performance are thus present within the musicians.

Even though the typologies in both studies Spahn et al. (2021) and Papageorgi (2021) are not identical, they indicate that patterns can be found and described with regard to the factors symptoms of MPA, coping with MPA, general anxiety, self-esteem and self-efficacy. In this respect, the typology of the present sample of amateur musicians confirms the described typologies on the one hand and makes clear on the other hand that they exist independently of age and of professional or amateur status and show only gradual differences.

4.3. Dispositional and performance-specific MPA

For the assessment of MPA in our amateur musicians, we asked ourselves what relationship could be described between dispositional MPA and experienced MPA in the musicians' joint concert. An important result was that no statistical correlation was found between the groups low, medium, and high in dispositional MPA and the types 1, 2, and 3 in the PQM-Scales over the performance.

Significant correlations between dispositional MPA and performance-specific scales of the PQM were found consistently for self-efficacy, both before and during and after performance. In our view, this validates both questionnaire instruments, especially since items on self-efficacy are included in the K-MPAI. In addition, it was striking that correlations between dispositional MPA in the K-MPAI with the PQM scales correlate after performance and not - with the exception of self-efficacy – with the PQM scales before and during performance.

The results are not easy to classify. One interpretation could be that in the situation after the performance personality-related factors, as depicted by the K-MPAI, gain stronger influence, whereas before and during the performance the adrenergic reaction associated with the performance is more prominent. However, the relationship between the dispositional MPA, which surveys enduring experiences with performance situations, and the MPA related to a specific performance raises fundamental questions that, in our view, are not specific to the group of amateur musicians.

Overall, the possible assumption that musicians with high levels of dispositional MPA might also show high levels of MPA in certain performances could only be partially confirmed. The lack of a significant distribution pattern between the K-MPAI groups and the PQM Types showed that there is no overall relation between both. Musicians with high dispositional MPA can also have experienced a very moderate to low MPA in the concert. Our data show that the dispositional MPA seems to be less associated with the degree of functional coping or the symptoms of MPA in a particular performance, especially before and during the performance.

Furthermore, the distinction between dispositional and performance-specific MPA seems to be a current topic in recent publications (Spahn et al., 2021; Papageorgi, 2022). The distinction of these forms of MPA could be an important topic for future research.

The correlation between K-MPAI and the self-judged quality of the performance seems to be rather difficult. The results showed that between MPA and the performance quality there was no correlation. Ryan (2005) suggested a decreasing performance quality due to higher MPA. The finding indicate that the self-assessed quality of the performance is independent from the general MPA. However, it seems to be more related to the particular situation of the performance. Thus, the quality rating significantly correlated with the symptoms of MPA before the performance ($r = -0.38$) but this scale did not correlate with the K-MPAI.

The application of these results for practice seems to us to be particularly important with regard to a differentiated perception of performance experiences. In an active and resource-oriented view and analysis of a musical performance can lie the chance to develop a dynamic and realistic self-concept as a musician.

5. Limitations of the study

The limitations of the study are mainly due to the relatively small sample size. However, this disadvantage is partially offset by the homogeneity of the sample with respect to the instrument and age range. The study setting involved only one joint performance, however, even here there was a great consistency in the external factors, as all musicians performed under the same conditions.

The results and implications can only be generalized with reservations, especially since we are dealing with a specific group of amateur musicians in a brass choir. Overall, we consider the results of the study to be preliminary. The conclusions drawn here provide numerous starting points for further replication studies.

6. Conclusion

Young amateur musicians in our study showed individual differences with respect to the expression of dispositional MPA. Pre-performance symptoms of MPA were also high and pre-performance self-efficacy was low in some musicians. The results provide a differentiated picture of different expressions of MPA in young amateur musicians.

The present study provides new insights on MPA in a specific performance among young brass musicians in amateur music. This seems of particular importance given the few studies to date on this group of musicians on the topic of MPA. Overall, the results indicate that MPA plays a relevant role among these musicians and that it is worthwhile to keep the topic of coping with MPA in this group of musicians in mind and to give practical recommendations if needed.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the University Clinic Freiburg. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

PT did mainly the data collection. CS and MN performed the statistical analyses. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Barbar, A. E. M., de Souza Crippa, J. A., and de Lima Osório, F. (2014). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 152–154, 381–386. doi: 10.1016/j.jad.2013.09.041

Barros, S., Marinho, H., Borges, N., and Pereira, A. (2022). Characteristics of music performance anxiety among undergraduate music students: a systematic review. *Psychol. Music* 50, 2021–2043. doi: 10.1177/03057356211066967

Bersh, B. (2022). The relationship between music performance anxiety and self-efficacy in sixth- to eighth-grade instrumental students. *Psychol. Music* 50, 1477–1493. doi: 10.1177/03057356211050667

Castiglionea, C., Rampullo, A., and Cardulloa, S. (2018). Self representations and music performance anxiety: a study with professional and amateur musicians Europe's. *J. Psychol.* 14, 792–805. doi: 10.5964/ejop.v14i4.1554

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (*2nd*). Hillsdale, NJ: Lawrence Erlbaum Associates

Cohen, S., and Bodner, E. (2021). Flow and music performance anxiety: the influence of contextual and background variables. *Music. Sci.* 25, 25–44. doi: 10.1177/1029864919838600

Dempsey, E., and Comeau, G. (2019). Music performance anxiety and self-efficacy in young musicians: effects of gender and age. *Music Perform. Res.* 9, 60–79.

Dobos, B., Piko, B. F., and Kenny, D. T. (2019). Music performance anxiety and its relationship with social phobia and dimensions of perfectionism. *Res. Stud. Music Educ.* 41, 310–326. doi: 10.1177/1321103X18804295

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disord.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/S0033291719001910

Fishbein, M., and Middlestadt, S. E. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Probl. Perform. Art.* 3, 1–8.

González, A., Blanco-Piñeiro, P., and Díaz-Pereira, M. P. (2018). Music performance anxiety: exploring structural relations with self-efficacy, boost, and self-rated performance. *Psychol. Music* 46, 831–847. doi: 10.1177/0305735617727822

Guyon, A. J. A. A., Studer, R. K., Hildebrandt, H., Horsch, A., Nater, U. M., and Gomez, P. (2020). Music performance anxiety from the challenge and threat perspective: psychophysiological and performance outcomes. *BMC Psychol.* 8:87. doi: 10.1186/s40359-020-00448-8

Kenny, D. T. (2009). "Negative emotions in music making: performance anxiety" in *Handbook of music and emotion: Theory, research, applications*. eds. P. Juslin and J. Sloboda (Oxford, UK: Oxford University Press), 425–451.

Kenny, D.T. (2011). *The psychology of music performance anxiety*. UK: Oxford University Press

Kenny, D.T. (2015). Identifying cut-off scores for clinical purposes for the Kenny music performance anxiety inventory (K-MPAI) in a population of professional orchestral musicians. Technical Report. Available at: https://www.researchgate.net/publication/282735405_Identifying_cut-off_scores_for_clinical_purposes_for_the_Kenny_Music_Performance_Anxiety_Inventory_K-MPAI_in_a_population_of_professional_orchestral_musicians

Kenny, D. T. (2023). The Kenny Music Performance Anxiety Inventory (K-MPAI): scale construction, cross-cultural validation, theoretical underpinnings, and diagnostic and therapeutic utility. *Front. Psychol.* 14:1143359. doi: 10.3389/fpsyg.2023.1143359

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Disord.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kenny, D. T., Driscoll, T., and Ackermann, B. (2012). Psychological well-being in professional orchestral musicians in Australia: a descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T., and Osborne, M. S. (2006). Music performance anxiety: new insights from young musicians. *Adv. Cogn. Psychol.* 2, 103–112. doi: 10.2478/v10053-008-0049-5

Le Blanc, A., Jin, Y.C., Obert, M., and Siivola, C. (1997). Effect of audience on music performance anxiety. *J. Res. Music. Educ.* 45, 480–496. doi: 10.2307/ 3345541

McCormick, J., and McPherson, G. (2003). The role of self-efficacy in a musical performance examination: an exploratory structural equation analysis. *Psychol. Music* 31, 37–51. doi: 10.1177/0305735603031001322

Nusseck, M., Zander, M., and Spahn, C. (2015). Music performance anxiety in young musicians: comparison of playing classical or popular music. *Med. Probl. Perform. Art.* 30, 30–37. doi: 10.21091/mppa.2015.1005

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., and McPherson, G. E. (2021). Social support as a facilitator of musical self-efficacy. *Front. Psychol.* 12:722082. doi: 10.3389/fpsyg.2021.722082

Osborne, M. S., and Kenny, D. T. (2005). Development and validation of a music performance anxiety inventory for gifted adolescent musicians. *J. Anxiety Disord.* 19, 725–751. doi: 10.1016/j.janxdis.2004.09.002

Osborne, M. S., and Kirsner, J. (2022). "Music performance anxiety" in *The Oxford handbook of music performance: enhancements, health and wellbeing* ed. G. E. McPherson (Oxford: Oxford University Press), 204–231. doi: 10.1093/oxfordhb/9780190058869.013.1

Papageorgi, I. (2021). Typologies of adolescent musicians and experiences of performance anxiety among instrumental learners. *Front. Psychol.* 12:645993. doi: 10.3389/fpsyg.2021.645993

Papageorgi, I. (2022). Prevalence and predictors of music performance anxiety in adolescent learners: contributions of individual, task-related and environmental factors. *Music. Sci.* 26, 101–122. doi: 10.1177/1029864920923128

Papageorgi, I., Creech, A., and Welch, G. (2013). Perceived performance anxiety in advanced musicians specializing in different musical genres. *Psychol. Music* 41, 18–41. doi: 10.1177/0305735611408995

Papageorgi, I., Hallam, S., and Welch, G. F. (2007). A conceptual framework for understanding musical performance anxiety. *Res. Stud. Music Educ.* 28, 83–107. doi: 10.1177/1321103X070280010207

Patston, T., and Osborne, M. S. (2016). The developmental features of music performance anxiety and perfectionism in school age music students. *Perform. Enhanc. Health* 4, 42–49. doi: 10.1016/j.peh.2015.09.003

Ryan, C. (2005). Experience of musical performance anxiety in elementary school children. *Int. J. Stress. Manag.* 12, 331–342. doi: 10.1037/1072-5245.12.4.331

Sickert, C., Klein, J. P., Altenmüller, E., and Scholz, D. S. (2022). Low self-esteem and music performance anxiety can predict depression in musicians. *Med. Probl. Perform. Art.* 37, 213–220. doi: 10.21091/mppa.2022.4031

Simoens, V. L., Puttonen, S., and Tervaniemi, M. (2015). Are music performance anxiety and performance boost perceived as extremes of the same continuum? *Psychol. Music* 43, 171–187. doi: 10.1177/0305735613499200

Sokoli, E., Hildebrandt, H., and Gomez, P. (2022). Classical music students' pre-performance anxiety, catastrophizing, and bodily complaints vary by age, gender, and instrument and predict self-rated performance quality. *Front. Psychol.* 13:905680. doi: 10.3389/fpsyg.2022.905680

Spahn, C. (2011). "Lampenfieber bei Musizierenden im Kindes- und Jugendalter" in *Schriftenreihe Kinder und Jugendstimme "Stimme – Persönlichkeit – Psyche"*. ed. M. Fuchs (Berlin: Logos Verlag), 155–163.

Spahn, C. (2012): *Lampenfieber: Handbuch für den erfolgreichen Auftritt. Grundlagen, Analyse, Maßnahmen*. Leipzig: Henschel Verlag.

Spahn, C. (2015). Treatment and prevention of music performance anxiety. *Prog. Brain Res.* 217, 129–140. doi: 10.1016/bs.pbr.2014.11.024

Spahn, C., Krampe, F., and Nusseck, M. (2021). Classifying different types of music performance anxiety. *Front. Psychol.* 12:538535. doi: 10.3389/fpsyg.2021.538535

Spahn, C., Walther, J.-C., and Nusseck, M. (2016). The effectiveness of a multimodal concept of audition training for music students in coping with music performance anxiety. *Psychol. Music* 44, 893–909. doi: 10.1177/0305735615597484

Studer, R. K., Danuser, B., Hildebrandt, H., Arial, M., Wild, P., and Gomez, P. (2012). Hyperventilation in anticipatory music performance anxiety. *Psychosom. Med.* 74, 773–782. doi: 10.1097/PSY.0b013e31825e3578

Zimmermann, J., and Louven, C. (2017). "Auftrittsangst und Auftrittserlebnis bei Musikstudierenden - eine Mixed-Methods Studie zu Einflussfaktoren, biografischer Entwicklung und Vorbereitungsstil" in *Musikpsychologie. Jahrbuch der Deutschen Gesellschaft für Musikpsychologie. Akustik und musikalische Hörwahrnehmung*. eds. W. Auhagen, C. Bullerjahn and C. Louven (Göttingen: Hogrefe), 128–152.

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Teachers' approaches to music performance anxiety management: a systematic review

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Performance anxiety is a widespread issue that can affect musicians across their education and career. It can develop in musicians from a young age leading to short-term and long-term impacts on not only their performance, but also their wellbeing. There is potentially a significant role that music educators hold in the development of their students and how they handle performance anxiety, though it is not clear how, or how often, teachers support their students in this way. Through a PRISMA-based systematic review, this paper explores what is known about the strategies used by music educators to help manage their students' performance anxiety. The paper also discusses the role that instrumental/vocal tutors and school classroom teachers might hold in this area. The findings show that music educators are implementing multiple strategies to assist their students with MPA, with the most common being simulated performance, positive outlook, preparation and breathing. It was found that there is a role for teachers to address MPA management with their students. While some students prefer to receive MPA support from experts in the field of psychology, students still expressed a need to have this support come from their teacher. Though many teachers felt a need for additional training for them to help their students cope with MPA, many of the strategies were found to be multifunctional and embedded into the regular teaching practices or teaching styles of the educator. Although these strategies might be implicit rather than explicit, the findings suggest that music educators could represent a valuable source of support for MPA management.

KEYWORDS

stage fright, performance pedagogy, music education, music performance, PRISMA, music pedagogy, music studio teaching, instrumental and vocal teaching

1. Introduction

Performance anxiety is a widespread area of concern that can impact individuals across a range of endeavors, including public speaking, sport, and performing arts including dancing, acting and music. According to Marchant-Haycox and Wilson (1992), amongst the performing arts, it is musicians who are the most affected by performance anxiety. An emphasis on high standards, often subject to intense scrutiny, creates a constant pressure for musicians to meet their own and others' expectations. The effect of a rigorous routine of practicing, rehearsing and performing, can often result in somatic complaints and emotional fatigue, particularly in young musicians (Stoeber and Eismann, 2007). Consequently, ambitious musicians must not only excel in technical skills and musicality, but importantly, must develop stamina in order to endure the physical and mental demands of performance (Sušić, 2018).

There are many studies that explore these issues, investigating potential causes, symptoms, and strategies that musicians use to cope with music performance anxiety (MPA) (Fehm and Schmidt, 2006; Biasutti and Concina, 2014; Kenny et al., 2014). However, there is little research focused on how this knowledge is applied, particularly by music teachers, who are typically, implicitly trusted to prepare the developing musician for a professional career. This review provides an overview of what is known about how various music educators, including instrumental/vocal tutors, school classroom teachers and university teachers, support their students with MPA. The objectives of this review are:

1. To identify what strategies are used by music educators to help manage their students' performance anxiety;
2. To understand whether music educators have a role in the MPA management of their students.

2. Literature review

There are two papers already that systematically reviewed the literature on MPA in relation to music education (Blair and van der Sluis, 2022; MacAfee and Comeau, 2022). Blair and van der Sluis (2022) identified interventions across the literature that could be generalized in higher education settings, including mental skills training, cognitive and imagery strategies, performance psychology training, multimodal coping strategies, biofeedback training, heartrate/biofeedback and emotional refocusing, music performance skills courses, acceptance and commitment therapy, meditation, mindfulness, yoga, desensitization, virtual reality exposure, exam scheduling, and expressive writing. However, the researchers acknowledged that many of the interventions tended to rely heavily on specialist training, delivered by expert physicians or psychologists, rather than music educators. The review by Blair and van der Sluis (2022) contributed to what is known about transferring tested interventions to the teaching setting, but as the strategies' applicability to higher education training was limited, further investigation into how music educators commonly implement MPA management strategies in their everyday teaching is still needed.

MacAfee and Comeau (2022) have also reviewed the MPA literature to identify the five most common strategies music teachers use to support young musicians with MPA. Differing from the previous paper, this paper took professional literature into account, such as magazines and newsletter articles written by studio instrumental teachers, as well as scientific literature. The authors found that preparation, open communication, realistic expectations, exposure to performance, and deep breathing were the most common strategies. The paper also included an analysis of semi-structured interviews with five private piano teachers to explore how these teachers described the five identified strategies reported in the literature, which will be examined in the Results and Discussion of this paper. The review by MacAfee and Comeau (2022) focused on how music teachers support young students with MPA; however, given that performance anxiety can affect musicians of all ages, understanding how teachers manage this issue with older students is also necessary and requires further research.

Typically, the role of the teacher in the development of students' performance skills is regarded as important, but their role in the development and management of MPA is unclear (Ryan and Andrews, 2009). Research has shown that musicians can experience MPA across varying points of their musical studies and career. Kaleńska-Rodzaj (2020) found that among musicians aged 9 to 12, of the 45% of participants who experienced MPA, 31% believed it had a negative impact on their performance, and 18% reported helplessness in coping with it. Many studies have also found MPA to be common at university and professional level (Fishbein et al., 1988; Kenny et al., 2004; Sousa et al., 2016), with some research showing that tertiary-level music students experience higher frequencies of MPA than professional musicians (Steptoe and Fidler, 1987; Wesner et al., 1990; Tamborrino, 2001). University students are at the beginning of their professional career and are at a stage of their development where they are likely to receive more criticism than in the past. In addition, higher education includes more musicians, most of whom do not progress to become professional performers. This might reflect the higher frequency of MPA that they experience and might suggest that a failure to manage MPA can obstruct careers as professional musicians before they start (Fehm and Schmidt, 2006; Patston and Osborne, 2016). Whether a student is learning music as an aspiring professional or for leisure, MPA can still be a significant issue impacting their overall wellbeing and enjoyment of performing. The need for support in MPA prevention and management at an early stage, and throughout a musician's education might therefore be crucial to their development as a musician.

Due to the prevalence of MPA among musicians across varying points of their musical studies and career, research has focused on how to alleviate this issue. Studies have shown that social support can play a significant role in managing MPA, particularly from instrumental teachers and peer support within institutional settings (Tahirbegi, 2019). Social support includes various types of psychological assistance, often provided by significant people within the learner's environment such as family, teachers, and peers (Orejudo et al., 2021). However, those who experience severe MPA may not seek help due to a perceived stigma around this problem and shame in admitting that they suffer from MPA. Wesner et al. (1990) reported that only about 15% of undergraduate student musicians affected by MPA seek help. This might make it difficult for educators to be aware of a student suffering MPA, and to identify the need for support. For educators to recognize instances of MPA within their students and to assist in the management of MPA, there must be an understanding of how musicians themselves experience it and their coping tendencies (Tahirbegi, 2019).

The one-to-one tutor may be well placed to assist with MPA management, Kokotsaki and Davidson (2003) suggesting that they have the potential to understand their students' background, experience, and emotional processes. With this knowledge and the dedicated time that they have with each student on a regular basis, they may be in a good position to discuss psychological issues with their students, such as MPA (Mahony et al., 2022). Classroom music teachers and university teachers might hold

a similar role in supporting their students with MPA because, according to Mahony et al. (2022), there is an increasing need for educators in this context to help handle their students' mental health needs. At university level, some institutions are recognizing the need to provide MPA intervention courses for their students and research has looked at how to integrate these interventions into course settings (Spahn et al., 2016). Therefore, the education space has made progress in addressing MPA to support student musicians.

This study addresses the above stated objectives through an overview of the role that educators hold in the MPA management of their students. A particular focus on the MPA strategies that are commonly used in day-to-day lessons, as distinct from interventions that could be generalized in higher education settings (Blair and van der Sluis, 2022), will also be examined.

3. Method

The approach taken in this paper is a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)-based systematic review (Liberati et al., 2009).

The inclusion criteria used in the review of the literature are listed below:

- *Types of studies:* Articles reporting original research using both quantitative and/or qualitative methodologies such as questionnaires and/or face-to-face and/or online interviews.
- *Types of participants:* Music educators including instrumental/vocal tutors, school classroom teachers and/or university teachers. Undergraduate music students were also included as there were several studies that reported

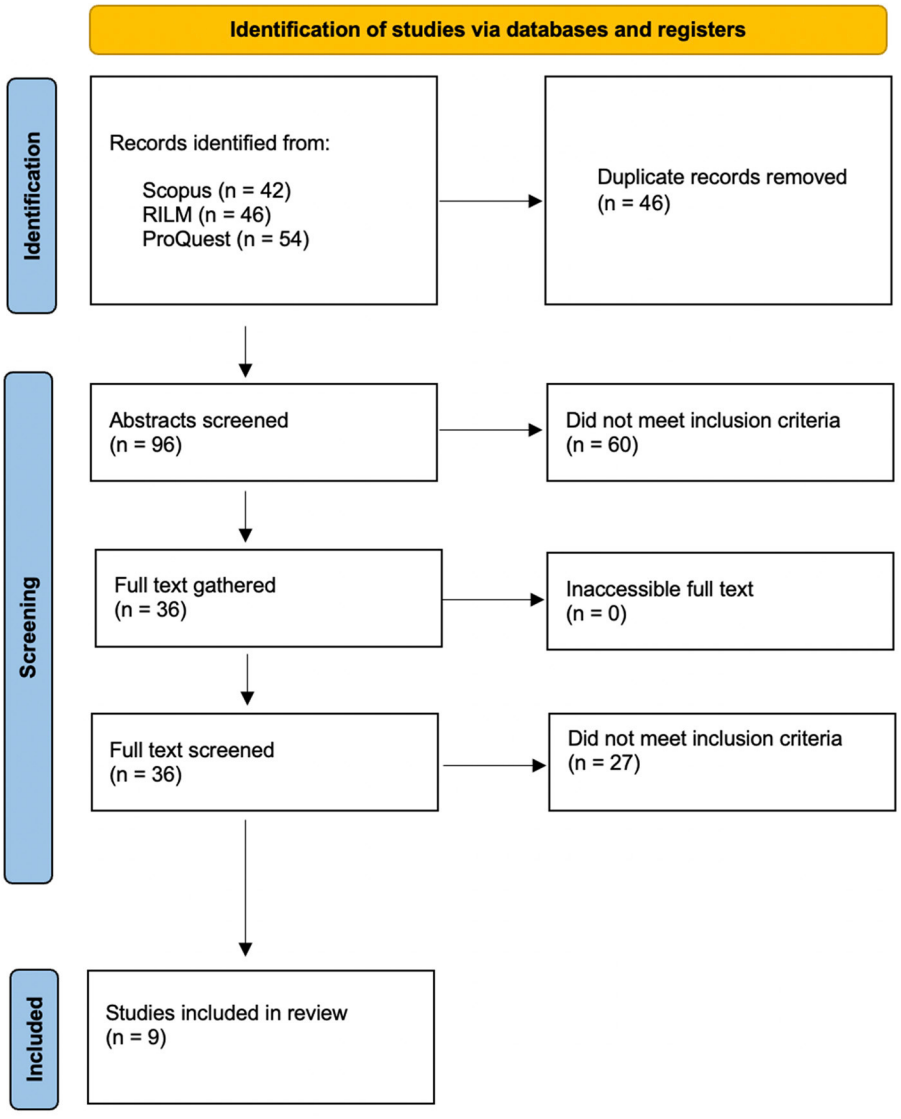

FIGURE 1
The PRISMA screening process (Page et al., 2021).

TABLE 1 Characteristics of articles included in the review.

References	Title	Aim	Research method	Participants
Cornett and Urhan (2021)	Performance anxiety experiences and coping techniques of Turkish music students and their teachers	To investigate the MPA experiences of musicians in Turkey, including their physical and cognitive symptoms of anxiety, their methods of coping with performance stress, and their perceived need for related resources.	Questionnaire	35 teachers, 230 students
Gill et al. (2022)	Sources of self-efficacy in class and studio music lessons	To understand how music educators foster self-efficacy for performing and enable students to manage the psychological and physiological arousal that accompanies performance situations.	Questionnaire	176 studio music teachers and 128 school music educators
Huang and Yu (2022)	Social support in university music students' coping with performance anxiety: People, strategies and performance situations	To explore the collaborative nature of university music students' MPA coping throughout instrumental/vocal learning and performance preparation.	Semi-structured interviews	99 undergraduate music students
MacAfee and Comeau (2022)	Teacher perspective on music performance anxiety: An exploration of coping strategies used by music teachers	To explore MPA from music teachers' perspectives by identifying and describing common coping strategies teachers use to support students with MPA.	Semi-structured interviews	5 private piano teachers
Moura and Serra (2021)	Listening to teachers' voices: Constructs on music performance anxiety in artistic education	To investigate instrumental teachers' voices to provide a representation of MPA management practices and conceptions.	Semi-structured interviews	4 instrumental tutors (1 keyboard tutor, 1 wind tutor, 2 strings tutors)
Ryan et al. (2021)	Performance preparation, anxiety, and the teacher. Experiences of adolescent pianists	To examine the experiences of adolescent pianists in their private lessons and solo performances in regard to concert preparation and MPA.	Questionnaire	62 adolescent piano students
Sieger (2017)	Music performance anxiety in instrumental music students: A multiple case study of teacher perspectives	To investigate the strategies and methods utilized by middle and high school music teachers to address the MPA experienced by their students.	Multiple case study (interviews and follow up interviews)	3 middle and high school instrumental music teachers
Studer et al. (2011)	Stage fright: Its experience as a problem and coping with it	To assess negative feelings of MPA before performing, the experience of stage fright as a problem, and how closely they are associated with each other.	Questionnaire	190 undergraduate music students
Tahirbegi (2019)	Higher music education students' experiences and management of performance anxiety: A qualitative study	To investigate students' experiences and management of MPA in educational settings.	Semi-structured interviews	10 undergraduate music students

on approaches taken by musicians' teachers to support them with MPA management.

- *Types of intervention:* Articles referring to strategies used to manage MPA in the teaching setting, or the role that educators hold in this area.
- *Language of publication:* Articles published in English.
- *Publication status:* Final and Article in Press.
- *Rigor:* Peer-reviewed articles.
- *Date range of publications:* Articles published over two decades, set as 1 January 2003 to 31 December 2022.

3.1. Information sources and study selection

Studies were identified by searching electronic databases. This search was applied to Scopus, Répertoire International de Littérature Musicale (RILM) and ProQuest. The following search terms were applied to the title, abstract and keywords across the databases: "music performance anxiety" AND ("teacher" OR "education" OR "pedagogy"). The search provided a total of 96 articles, excluding duplicates (Figure 1). The abstract of each of these articles were examined. Of these, 60 were discarded because they did not meet the inclusion criteria of the intervention type: they did not make reference to teaching strategies used to manage MPA or the role that educators hold in this area. The full text of the remaining 36 articles was examined in more detail. Of these articles, 27 did not meet the inclusion criteria of the intervention type. This left 9 studies that met the inclusion criteria and were included in the review (see Table 1). Of these studies, six referred to strategies used by music educators to manage MPA in the teaching setting (Table 2) and six referred to the role that educators hold in MPA management (Table 3). Figure 1 shows the PRISMA flow diagram (Page et al., 2021).

4. Results

The full text of the articles that met the research conditions was examined and explicit strategies were noted and coded into relevant themes. For example, articles that mentioned "performance opportunities", "performance exposure", "performance practice",

TABLE 2 Strategies identified across the literature.

	Sieger (2017)	Moura and Serra (2021)	Gill et al. (2022)	Huang and Yu (2022)	MacAfee and Comeau (2022)	Ryan et al. (2021)
Breathing	X	X		X	X	X
Diet				X		
Focused attention	X	X	X			X
Imagery			X	X		
Open MPA discussions	X	X	X		X	
Physical activity	X					
Positive outlook	X	X	X	X		X
Pre-performance routines			X			
Preparation	X	X	X		X	X
Psychological performance skills			X			
Repertoire					X	
Safe environment	X	X				
Self-talk			X			
Simulated performance	X	X		X	X	X
Suppression						X
Visualization	X		X	X		

or "playing through repertoire in front of family/friends" were regarded as "simulated performance"; "play for fun", "mistakes don't matter", and "you'll be happy you did it" were regarded as "positive outlook". Coding was completed by author IM and cross-checked with all authors. Information was extracted from each article including: types of studies (questionnaires and/or interviews), aim of the paper, types of participants (types of music educators and/or students), strategies identified and/or viewpoints on the role of addressing MPA. Examining the methods used in the reported studies, it was found that 4 of the studies used questionnaires, while 5 of the studies used semi-structured interviews.

We then examined the strategies used by music educators to help manage their students' performance anxiety. Several strategies were identified across the articles including: preparation (in 5 articles), simulated performance (5), positive outlook (5), breathing (5), focused attention (4), open MPA discussions (4), visualization (3), safe environment (2), imagery (2), repertoire (1), physical activity (1), psychological performance skills (1), pre-performance routines (1), self-talk (1), diet (1), and suppression (1) (see Table 2).

Table 3 provides an overview of the articles which referred to the role that educators hold in MPA management. A range of perspectives was found from both students and teachers, with some students and teachers believing that it is the teacher's role to address MPA management, while other students felt experts in the field such as psychologists, psychotherapists, or general practitioners, would be more suitable. Most teachers believed that they needed additional training in MPA management to support their students in this area.

5. Discussion

The reviewed literature offered a broad discussion of teachers' approaches to MPA management. Interestingly, almost all of the articles included in this review were published in the past two years, suggesting that there is an emerging interest in this topic from a pedagogical perspective. An array of strategies used by teachers to support their students with MPA were identified in the papers. The following strategies appeared most frequently, with each mentioned in five of the studies: preparation, simulated performance, positive outlook and breathing. These strategies overlap with the findings from MacAfee and Comeau (2022), who also found that preparation, simulated performance and breathing were the most common MPA strategies used by teachers, along with open communication.

Cognitive strategies emerged as less frequent in the present review which focused on common teaching practices, than in the studies reviewed by Blair and van der Sluis (2022), who focused on interventions that could be generalized to higher education settings. Blair and van der Sluis (2022) defined cognitive strategies as those that include "cognitive psychology and therapeutic interventions using cognitive and imagery strategies to manage or treat MPA" (p. 9). In the study by Gill et al. (2022), fewer than half the studio tutors and classroom teachers used psychological performance skills to combat MPA, and those that did would mostly only do so if the student was already experiencing MPA problems. This further supports a key finding from Blair and van der Sluis (2022), that a significant level of training or support might be required to implement cognitive strategies into regular teaching,

TABLE 3 Teacher and student perceptions of teachers' role in MPA management.

References	Theme	Findings
Cornett and Urhan (2021)	Expert help needed	When asked about resources for MPA management, 20.8% of students would like to work with an expert in the field of MPA management and 33.8% mentioned that psychological support would be useful.
Moura and Serra (2021)	Training required	All 4 teachers said it is part of their role as educators to address MPA, but mentioned they require more training such as practical MPA management projects during university classes and further academic education in this area.
Ryan et al. (2021)	Teachers' role	42% of students said that their teachers provided advice about MPA management, but that much of this advice did not effectively address the issue or provide tangible coping strategies.
Sieger (2017)	Training required	All 3 teachers said that more training is needed in MPA management. One teacher noted they avoid addressing MPA due to the stigma around the topic.
Studer et al. (2011)	Teachers' role, expert help needed	Majority of students (73%) would like to receive support in MPA management from specialists (e.g., psychologists, psychotherapists, or general practitioners), but more than half of the students (56%) would like to receive more information from their university teacher about MPA management.
Tahirbegi (2019)	Teachers' role, expert help needed	All students mentioned the importance of receiving emotional support from their teachers. Some students said they did not feel comfortable discussing MPA with their teachers (exact number of students unknown).

as these cognitive strategies are often used by experts in the field of psychology.

In this review and the literature, the terms "strategies", "MPA management strategies", "coping skills", "coping strategies", and "coping tools" have been most commonly used to refer to the ways in which educators have supported their students with MPA (Moura and Serra, 2021; Gill et al., 2022; Huang and Yu, 2022; MacAfee and Comeau, 2022). Arguably, however, the strategies are multifunctional, in that they enhance both performance skills and MPA management (Huang and Yu, 2022), so it might be more appropriate to identify these strategies as coinciding with the regular teaching practice of the educator, which indirectly influences MPA, rather than explicit strategies. This reflects a finding identified by Huang and Yu (2022), that several students felt their teachers were not aware of their role in supporting their students with MPA management, but rather, they supported their students in an implicit way as the strategies were already embedded into their regular pedagogical process. For example, preparation, which involves task-oriented strategies such as technical drills, mastering specific phrases, slow practice, and repetition (Moura and Serra, 2021), is often a teacher's priority, regardless of their students' MPA situation. In this regard, preparation improves confidence through task mastery, therefore—perhaps incidentally—minimizing MPA (Gill et al., 2022).

Similarly, Moura and Serra (2021) made reference to "MPA management pedagogical practices", "MPA management strategies", and the "development of intervention projects", all of which blur the distinction between MPA management and more general approaches to studio teaching. The authors argued that MPA strategies should not be taught independently to avoid inflaming MPA, aligning with the idea that MPA management is not commonly taught through concern of enhancing it and is clouded by the stigma around the topic (Sieger, 2017). Instead, Moura and Serra (2021) recommended that MPA management strategies should be integrated into performance teaching: into the regular pedagogical practices of the teacher. This was reflected by their findings of teachers who reported mentoring their students in MPA management as part of their role as an educator, integrating it into their lessons through strategic activities such as simulated performance. This prominent strategy can increase self-efficacy when students succeed in relatively low-intensity environments and so experience greater comfort on stage (MacAfee and Comeau, 2022).

Embracing a positive outlook, too, might be regarded more as a teaching style rather than strategy. It includes teachers reacting positively to mistakes and normalizing errors as opportunities for learning (Sieger, 2017; Moura and Serra, 2021). One example was reported by Gill et al. (2022) who highlighted the term "verbal persuasion", which refers to feedback and encouragement from others, as a strategy for teachers to use to enhance the self-efficacy and therefore, reduce the performance anxiety of students. A similar example came from Moura and Serra (2021), who reported teachers boosting the confidence of their students by highlighting how well prepared they are for their performance. Teachers embracing a positive outlook may help students to adopt this same attitude, increasing their self-efficacy and thereby reducing MPA. Whether teachers embrace a positive outlook might be dependent on whether they foster an encouraging environment and normalize mistakes, rather than being more focused on perfectionism and mastery.

Perhaps accordingly, a distinction has been made between focusing on technique and mastery, and addressing the affective aspects of being a musician; thus, Tahirbegi (2019) found a divergence between students who shared experiences of MPA with their instrumental tutors, and those who did not. Some students reported feeling comfortable discussing MPA with their teachers as they felt their teachers could meet them at an emotional level, while others said that their teachers could not offer help in MPA management or the emotional aspects of music, but were more focused on assisting them with technical and musical skills. The apparent failure of some teachers to offer emotional support is inconsistent with the emphasis on positive outlook noted previously, which evokes the value of relational qualities such as empathy, congruence, and unconditional positive regard, which might correlate better with good psychotherapy outcomes (Shaw et al., 2020).

While a range of MPA strategies had been identified across the literature, it seems clear that some educators feel ill-equipped to tackle MPA because of a lack of training or being unqualified in the area (Moura and Serra, 2021). All three of the teachers in

the study by Sieger (2017) remarked that they would benefit from training in this area. Huang and Yu (2022) found that both students and teachers said that there was still a need for expert help from psychologists, psychotherapists or general practitioners. However, it is also clear that teachers can play a valuable role in this area. Studer et al. (2011) found that while 73% of the 190 undergraduate students in their study would like expert help in the field, more than half of them would like to receive this support from their university teacher. If teachers are made more aware of the overlap between teaching styles or approaches that are already embedded into regular teaching and explicit strategies designed to support MPA management, then perhaps they will feel more confident about addressing this important issue.

6. Limitations

The main limitation of this paper is due to the small number of articles that met the inclusion criteria. The inclusion criteria were focused on studies that investigated MPA management strategies that are used commonly in the teaching environment, rather than studies that test the transfer of specific MPA interventions in the teaching setting, of which there are numerous studies. The inclusion criteria were also focused on the role that teachers hold in this area. The small number of articles, and the fact that 6 of the 9 articles date from the last two years, indicates that this is a relatively new area of research, that is proceeding rapidly.

7. Conclusion

The purpose of this review was to investigate strategies used by music educators to support their students with MPA, and to explore their role in addressing MPA management with their students. A total of 96 articles were identified in the initial scoping of the literature. This was reduced to 9 articles that met the inclusion criteria.

The literature reviewed suggests that studio and classroom teachers are using multiple strategies in their lessons to support their students with MPA, with the most common being simulated performance, positive outlook, preparation, and breathing. There is evidence from the literature that there is a role for teachers to address MPA management with their students. While some students might prefer support from experts in the field of psychology, there is still demand for this support to come from the teacher. Though some teachers expressed a need for additional training in MPA management, the exploration of the literature showed that many of the strategies may be embedded in regular teaching practices to assist with the affective aspects that come with being a musician. This suggests that some of the strategies to combat MPA can be acquired from the teacher, without onerous additional training. With this understanding, perhaps supported by professional development, music educators may find that tackling the issue of MPA is more manageable under their remit. As multiple assumptions exist on whether it is the role of the teacher to manage their students MPA, this issue calls for further exploration.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Author contributions

IM conducted the systematic review, analyzed the data, and wrote the drafts of the manuscript. KB and EM assisted with the analysis and editing of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Mus. Scient.* 18, 189–202. doi: 10.1177/1029864914523282

Blair, E., and van der Sluis, H. (2022). Music performance anxiety and higher education teaching: A systematic literature review. *J. Univ. Teach. Learn. Pract.* 19, 05. doi: 10.53761/1.19.3.05

Cornett, V., and Urhan, G. (2021). Performance anxiety experiences and coping techniques of Turkish music students and their teachers. *Int. J. Music Educ.* 39, 504–519. doi: 10.1177/02557614211005907

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disor.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fishbein, M., Middlestadt, S. E., Ottati, V., Straus, S., and Ellis, A. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Problems Perfor. Artists* 3, 1–8.

Gill, A., Osborne, M., and McPherson, G. (2022). Sources of self-efficacy in class and studio music lessons. *Res. Stud. Music Educ.* 4, 1321103X.221123234. doi: 10.1177/1321103X221123234

Huang, W.-L., and Yu, H. (2022). Social support in university music students' coping with performance anxiety: people, strategies and performance situations. *Music Educ. Res.* 24, 124–135. doi: 10.1080/14613808.2022.2028752

Kaleńska-Rodzaj, J. (2020). Pre-performance emotions and music performance anxiety beliefs in young musicians. *Res. Stud. Music Educ.* 42, 77–93. doi: 10.1177/1321103X19830098

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: A descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Disord.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kokotsaki, D., and Davidson, J. W. (2003). Investigating musical performance anxiety among music college singing students: A quantitative analysis. *Music Educ. Res.* 5, 45–59. doi: 10.1080/14613800307103

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med.* 6, e1000100. doi: 10.1371/journal.pmed.1000100

MacAfee, E., and Comeau, G. (2022). Teacher perspective on music performance anxiety: an exploration of coping strategies used by music teachers. *Br. J. Music Educ.* 40, 34–53. doi: 10.1017/S0265051722000146

Mahony, S. E., Juncos, D. G., and Winter, D. (2022). Acceptance and commitment coaching for music performance anxiety: Piloting a 6-week group course with undergraduate dance and musical theatre students. *Front. Psychol.* 13, 631. doi: 10.3389/fpsyg.2022.830230

Marchant-Haycox, S. E., and Wilson, G. D. (1992). Personality and stress in performing artists. *Person. Indiv. Differ.* 13, 1061–1068. doi: 10.1016/0191-8869(92)90021-G

Moura, N., and Serra, S. (2021). Listening to teachers' voices: constructs on music performance anxiety in artistic education. *J. Sci. Technol. Arts* 13, 99–117. doi: 10.34632/jsta.2021.9853

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., and McPherson, G. E. (2021). Social support as a facilitator of musical self-efficacy. *Front. Psychol.* 12, 722082–722082. doi: 10.3389/fpsyg.2021.722082

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *PLOS Medicine,* 18, e1003583. doi: 10.1371/journal.pmed.1003583

Patston, T., and Osborne, M. S. (2016). The developmental features of music performance anxiety and perfectionism in school age music students. *Perfor. Enhanc. Health* 4, 42–49. doi: 10.1016/j.peh.2015.09.003

Ryan, C., and Andrews, N. (2009). An investigation into the choral singer's experience of music performance anxiety. *J. Res. Music Educ.* 57, 108–126. doi: 10.1177/00224294093361 32

Ryan, C., Boucher, H., and Ryan, G. (2021). Performance preparation, anxiety, and the teacher. Experiences of adolescent pianists. *Revue Musicale OICRM* 8, 38–62. doi: 10.7202/1079790ar

Shaw, T. A., Juncos, D. G., and Winter, D. (2020). Piloting a new model for treating music performance anxiety: training a singing teacher to use acceptance and commitment coaching with a student. *Front. Psychol.* 11, 882. doi: 10.3389/fpsyg.2020.00882

Sieger, C. (2017). Music performance anxiety in instrumental music students: a multiple case study of teacher perspectives. *Contrib. Music Educ.* 42, 35–52. Available online at: https://www.jstor.org/stable/26367435

Sousa, C. M., Machado, J. P., Greten, H. J., and Coimbra, D. (2016). Occupational diseases of professional orchestra musicians from northern Portugal: a descriptive study. *Med. Problems Perfor. Art.* 31, 8–12. doi: 10.21091/mppa.2016.1002

Spahn, C., Walther, J.-C., and Nusseck, M. (2016). The effectiveness of a multimodal concept of audition training for music students in coping with music performance anxiety. *Psychol. Music* 44, 893–909. doi: 10.1177/0305735615597484

Steptoe, A., and Fidler, H. (1987). Stage fright in orchestral musicians: A study of cognitive and behavioural strategies in performance anxiety. *Br. J. Psychol.* 78, 241–249. doi: 10.1111/j.2044-8295.1987.tb02243.x

Stoeber, J., and Eismann, U. (2007). Perfectionism in young musicians: Relations with motivation, effort, achievement, and distress. *Person. Indiv. Differ.* 43, 2182–2192. doi: 10.1016/j.paid.2007.06.036

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Sušić, B. (2018). The relation between pedagogical approaches in music education and students performance anxiety. *Revija za elementarno izobraŽevanje* 11, 143–157. doi: 10.18690/rei.11.2.143-157.2018

Tahirbegi, D. (2019). Higher music education students' experiences and management of performance anxiety: A qualitative study. *Psychol. Music* 50, 1184–1196. doi: 10.1177/03057356211034573

Tamborrino, R. A. (2001). *An examination of performance anxiety associated with solo performance of college-level music majors*. Indiana University.

Wesner, R. B., Noyes Jr, R., and Davis, T. L. (1990). The occurence of performance anxiety among musicians. *J. Affect. Disor.* 18, 177–185. doi: 10.1016/0165-0327(90)90034-6

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It's not a virus! Reconceptualizing and de-pathologizing music performance anxiety

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Music Performance Anxiety (MPA) is one of the most widespread and debilitating challenges facing musicians, affecting significant numbers of performers in terms of both their personal and professional functioning. Although numerous interventions exist to target MPA, its prevalence remains unchanged since the first large-scale studies of the 1980s, indicating that available interventions are having limited impact. This review synthesizes and critiques existing literature in order to investigate possible reasons for the limited efficacy of current approaches to managing MPA. Key concepts discussed include conceptual and methodological challenges surrounding defining MPA, theoretical perspectives on MPA's etiology and manifestation, and the coping strategies and interventions used to manage MPA. MPA has predominantly been investigated pathologically and defined as a negative construct manifesting in unwanted symptoms. Based on this conceptualization, interventions largely seek to manage MPA through ameliorating symptoms. This review discusses possible reasons why this approach has broadly not proved successful, including the issue of relaxation being both unrealistic and counterproductive for peak performance, issues associated with intentionally changing one's state creating resistance thus exacerbating anxiety, and focusing on the presence of, rather than response to, symptoms. Despite 50 years of research, MPA remains an unsolved enigma and continues to adversely impact musicians both on and off the stage. Reconceptualizing MPA as a normal and adaptive response to the pressures of performance may offer a new perspective on it, in terms of its definition, assessment and management, with practical as well as theoretical implications.

KEYWORDS

music performance anxiety, MPA, musicians, interventions, theoretical literature review

1. Introduction

Public perception associates musical performance with entertainment, pleasure and relaxation (Hildebrandt et al., 2012). Indeed, the stage can be a place of creative freedom and artistic excellence, eliciting incredibly positive, even euphoric, states (Kenny, 2011). However, although musicians report higher levels of job satisfaction than other occupational groups (Harper, 2002), significant numbers experience occupation-related physical and psychological health problems that interfere with their personal and/or professional functioning, one of the most prevalent and debilitating of which is music performance anxiety (Fernholz et al., 2019).

Music Performance Anxiety (MPA) occurs in response to perceived threat and manifests physiologically, cognitively, emotionally, and behaviorally, ranging in intensity from normal stress intrinsic to performance to extreme levels of terror (Steptoe, 2001; Burin and Osório,

2017). MPA does not occur in isolation but interacts with stressors associated with a highly demanding, competitive and insecure work environment (Vervainioti and Alexopoulos, 2015) as well as numerous personality traits, including perfectionism, trait anxiety, cognitive style and coping style (Burin et al., 2019).

Experiencing acute anxiety can be psychologically distressing; over time, chronic anxiety can affect all aspects of performers' lives, including wellbeing, identity, self-worth and relationships (Kenny, 2011; Burin and Osório, 2017; Matei et al., 2018). *In extremis*, MPA may lead to post-traumatic stress disorders (Moura and Serra, 2021). Research indicates that prolonged neuroendocrine activation and overstimulation of the sympathetic nervous system can codetermine, or even cause, diseases including heart attacks and strokes (Benson and Klipper, 2009; Gomez et al., 2018). Alongside threatening performers' health and quality of life, MPA can reduce performance enjoyment, cause performance avoidance and impair performance quality (Kenny, 2011). At its most severe, MPA can constitute an occupational disability, terminating studies and careers (Orejudo et al., 2017; Fernholz et al., 2019). Sternbach (1993) describes the toxicity of MPA as making life preceding an important performance an *"unremitting purgatory"* for both performers, and those around them.

Given MPA's potentially devastating effects on musicians' lives and/or careers (Nagel, 2010), it is unsurprisingly one of the most widely researched topics in the fields of performance science and performing arts medicine, and there is now a substantial body of scholarship investigating MPA across a wide range of populations from a diverse range of theoretical and methodological perspectives. You may be wondering why on earth we need *YET ANOTHER* theoretical review of MPA. Despite decades of research and the development of numerous interventions, MPA's prevalence remains unchanged since the first large-scale studies in the 1980s (Fishbein et al., 1988; Fernholz et al., 2019), indicating that available interventions are not having a meaningful impact. MPA continues to pose a significant occupational challenge to musicians of all ages, genres, and nationalities, suggesting that gaps remain in our understanding of it (Fernholz et al., 2019). This theoretical review aims to explore possible reasons why MPA remains an unsolved enigma. Sections 2–6 will synthesize and critique existing research across the key concepts and issues in MPA research: Prevalence (2), Definitions (3), Etiology (4), Manifestation (5) and Management (6). Section 7 (Discussion) will then summarize current conceptualizations of MPA, before suggesting a paradigmatic reconceptualization.

2. Prevalence

MPA is described as ubiquitous (Nagel, 2010), an epidemic (McGrath, 2012) and universal (Brandfonbrener, 1999). But just how widespread really is MPA? Studies investigating prevalence among student and professional musicians report figures between 24 and 96%, indicating that MPA affects significant, yet ambiguous, numbers of musicians. While it is clear that MPA poses a serious challenge to students and professionals alike, the variability of findings casts little light on the issue of prevalence, precluding a clear understanding of the scale of the issue. This ambiguity can be attributed to methodological limitations within studies and heterogeneity across studies (Brugués, 2011a), as summarized in Table 1.

Most problematic are issues surrounding definitions and measurement tools (see Table 1). Unsurprisingly, prevalence varies enormously depending on the definition criteria used (Osborne and Kirsner, 2022). There is no consensus regarding what actually constitutes MPA, both in terms of conceptual clarity *within*, and heterogenous terminology *across*, studies. The diversity of terms used, as well as the very different constructs they represent, makes it impossible to know how many musicians experience the same phenomenon. This ambiguity is reflected in the diverse range of measures deployed. Within studies, the lack of a clear operational definition makes it impossible to know what exactly is being measured; across studies, the heterogenous assessment tools used preclude comparison between studies, making it impossible to build a strong evidence base (Kenny et al., 2014; Gembris et al., 2018).

MPA poses a major occupational challenge to significant numbers of musicians at all stages of professional development. However, if prevalence ranges from 24% to ubiquitous, it seems evident we are not all talking about the same phenomenon. Why does this matter? We suggest that the divergence regarding how many musicians experience MPA points to a more fundamental issue – how can we help musicians to manage a thing without knowing what that *thing* is? A phenomenon which affects a quarter of a particular population has very different implications than a phenomenon which affects *all* of a population. Arguably, the lack of a universal definition of MPA precludes comprehensive understanding, and thus effective management, of MPA. We now therefore turn to the challenge of defining MPA.

3. Definitions and theoretical perspectives

> "*Performance anxiety, like pornography, is easily recognised but difficult to define.*"

This quote by Lederman (1999, p. 117) illustrates a fundamental issue in MPA research – musicians and researchers alike know, intuitively, what MPA is, yet the phenomenon still lacks a common definition (Fernholz et al., 2019). This section will discuss the key challenges surrounding defining MPA: the heterogeneity of terms used to label the phenomenon, and the diverse conceptual constructs these terms represent.

3.1. Terminology

Across literature, different terms are used interchangeably and with conflicting hierarchies of severity (Studer et al., 2011). Pre-2009, authors largely created their own label and definition, applying only to their own study, precluding comparability of data and the formation of a coherent MPA theory. Some authors consider stage fright the most extreme manifestation of performance anxiety (Fishbein et al., 1988; Steptoe, 1989; Brodsky, 1996; Senyshyn, 1999), whereas others place stage fright below performance anxiety on their continuum of severity (Fehm and Schmidt, 2006). Van Kemenade et al. (1995) investigate performance anxiety that affects personal and/or professional functioning and (James, 1998) measures only anxiety

TABLE 1 MPA prevalence among conservatoire students and professional musicians including key methodological characteristics of the studies.

Study	Sample	Response rate	Definition used	Measures used	Key findings: MPA prevalence
Fishbein et al. (1988)	*N* = 2,212 musicians in 48 American orchestras	55%	Stage fright defined as the most extreme form of MPA (no operational definition of either construct).	Questionnaire developed by authors and ICSOM Music Medicine Committee. Participants circled relevant medical problems and indicated severity, defined by perceived impact on performance. Questionnaire not validated.	Stage fright was the most frequently reported serious physical/psychological problem, with 24% finding it problematic and 16% severely problematic.
Steptoe (1989)	*N* = 65 orchestral musicians (UK)	87%	MPA, performance anxiety, and stage fright used interchangeably; (no operational definition of any construct).	State–Trait Anxiety Inventory (State scale) (STAI-S) (Spielberger, 1983)	32% of participants were highly performance anxious.
Wesner et al. (1990)	*N* = 302 University of Iowa music students/ faculty	66.5%	Anxiety	Questionnaire developed by the authors measuring *"distress due to performance anxiety, impairment caused by anxiety, and treatment sought for it"* on a Likert scale (1–5) (p. 178)	21% reported "marked distress" and 40% experienced "moderate distress" while performing due to anxiety. 16.5% reported impaired performance quality due to anxiety. 16.1% believed performance anxiety had adversely impacted their careers.
Cox and Kenardy (1993)	*N* = 32 music students (UK)	53.3%	Performance anxiety is not defined.	- State–Trait Anxiety Inventory (Trait scale) (STAI-T) (Spielberger, 1983) - Performance Anxiety Questionnaire (PAQ) (Cox and Kenardy, 1993) (unvalidated) - Social Phobia & Anxiety Inventory (SPAI) (Turner et al., 1989)	100% of participants reported experiencing anxiety in performance; 84% considered anxiety to impair their performance; 96% reported experiencing performance-related stress.
Bartel and Thompson (1994)	*N* = 204 musicians in Canadian orchestras	21%	Questionnaire asks about 'stress related to performance' (not defined).	Questionnaire developed by the authors based on a focus group of musicians from the Toronto Symphony Orchestra as well as reviewed literature.	The authors concluded that professional orchestral life is 'extremely stressful', with a higher percentage of musicians experiencing stress than in the general workforce. The most effective coping strategy reported was beta-blockers.
Van Kemenade et al. (1995)	*N* = 155 musicians in Dutch orchestras	23.8%	Performance anxiety is not defined.	Questionnaire developed by the authors (unvalidated).	59% had experienced performance anxiety severe enough to impact their professional and/or personal lives, with anxiety manifesting up to months prior to important performances.
James (2000)	*N* = 1,639 musicians from 57 orchestras (worldwide)	50%	Anxiety sufficient to have an adverse impact on playing.	Questionnaire developed by the author (not included with publication).	70% of respondents reported anxiety severe enough to affect their performance, with 16% experiencing this degree of anxiety at least weekly.

(Continued)

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TABLE 1 (Continued)

Study	Sample	Response rate	Definition used	Measures used	Key findings: MPA prevalence
Kaspersen and Götestam (2002)	*N* = 126 conservatoire students in Norway	96.2%	Anxiety is not defined.	Questionnaire developed by the authors based on reviewed literature and knowledge of the Norwegian conservatoire system.	36.5% experienced MPA severely enough to require help. Only 8% reported no anxiety during musical performance.
Studer et al. (2011)	*N* = 190 music students in Swiss universities.	22%	*'Trac'*, translates as 'stage fright'. (Questionnaire in French)	Based on lack of universally agreed upon definition, MPA was assessed *via*: - State Trait Anxiety Inventory (State scale) (STAI-S) (Spielberger, 1983) to measure MPA's emotional dimension. - Rating of the degree to which participants considered stage fright to be a problem (0–4 scale)	One third of participants considered stage fright to be problematic. 20% of participants felt their performances were often impaired by stage fright.
Gembris and Heye (2012)	*N* = 2,536 musicians in German orchestras	26%	*'Lampenfieber'* translates loosely as stage fright. Not operationally defined here.	Questionnaire (in German) developed by authors based on qualitative pilot study ($n = 12$) and literature.	Over 90% suffered from MPA, with 50% reporting experiencing MPA to a small degree, 30% moderately and 13% severely.
Zakaria et al. (2013)	*N* = 55 undergraduate music students	92%	Uses terms 'performance anxiety' and 'stage fright' interchangeably. Defined as *"a constant, continuously distressful and impairment of performance skills in public context which may affect individual's musical aptitude training and level of performance"* (p. 227)	Questionnaire developed by the authors incorporating (1) demographics, (2) timeframe of performance anxiety, (3) symptoms and (4) coping strategies.	96% of participants reported experiencing performance anxiety sometimes during performance; 88% believed that their anxiety adversely impacted their playing.
Topoğlu et al. (2018)	*N* = 220 musicians in Turkish orchestras	57%	Uses Kenny (2009) definition.	Turkish version of the K-MPAI (Kenny, 2009)	81.8% experienced MPA, with 60% describing MPA as impairing their performances

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which adversely impacts performance, which is both vague and problematic. That stage fright has been considered both more AND less severe than MPA by different researchers adds further confusion to the prevalence statistics reported in Table 1.

Since 2009, researchers have increasingly adopted the definition offered by Kenny (2009) (see Section 3.3). However, discrepancies remain across the literature (Osborne and Kirsner, 2022), inhibiting understanding of the construct being investigated and posing a real challenge to the field in terms of methodological rigor, diagnostic criteria, evaluating prevalence and severity and designing appropriate interventions. In addition to heterogenous terminology, there is divergence regarding the nature of the phenomenon these terms are labeling. We now turn to various conceptualizations of MPA: negative, positive, both and intrinsic to performance. For clarity, this review will only use the term 'MPA'.

3.2. Conceptualizations of MPA

3.2.1. MPA as negative

MPA is largely researched through a pathological lens (Pecen et al., 2016) and described using medicalized language: *'condition'* (Barros et al., 2022; Moreno-Gutierréz et al., 2023), *'syndrome'* (Lederman, 1999), *'disabling'* (Brantigan et al., 1979; Lederman, 1999), *'illness'* (Harper, 2002), *'disease'* (Sousa et al., 2016; Fernholz et al., 2019), and *'disorder'* (Kenny, 2011; Fernholz et al., 2019; Mumm et al., 2020), requiring *'treatment'* (Spahn, 2015). The International Classification of Diseases defines performance anxiety as a specific phobia (ICD-10; Dilling and Freyberger, 2015), and the Diagnostic and Statistical Manual for Psychiatric Disorders (DSM 5; Falkai et al., 2015) codes it as a performance-only subtype of social anxiety disorder (SAD) (both cited in Mumm et al., 2020, p. 76–77).

Although some studies indicate correlations between MPA and aspects of SAD (Clark and Agras, 1991; Osborne and Kenny, 2005), recent evidence suggests that MPA and SAD are conceptually and empirically unrelated (Wiedemann et al., 2021). It appears that although MPA and SAD can manifest comorbidly and share similar aspects, they are distinct constructs (Bögels et al., 2010) and SAD is arguably not a useful diagnostic classification (Ruggiero, 2012), even in more extreme manifestations of MPA. In addition to a lack of empirical support for a connection between SAD and MPA, there are conceptual issues with linking the two constructs.

Although fear of evaluation is common to both MPA and the social anxiety disorders MPA tends to be diagnostically clustered with (Hays, 2009), there are arguably qualitative differences between performing and other social situations in terms of the physical and psychological challenges involved in performance (Kenny, 2011; Chang-Arana et al., 2018) as illustrated by the following quote:

> *"It is one thing to avoid cocktail parties (or funerals) because you feel uncomfortable in the presence of others. It is quite another, however, to diagnose a tenor as having a social phobia as a result of the following: He functions quite well in most social situations but feels at least momentarily daunted anticipating the thousand pairs of eyes and ears watching and listening as he opens his mouth to sing "Comfort Ye, My People," the initial vocal moment in Handel's Messiah"* (Hays, 2009 p. 105).

Conflating the two situations risks pathologizing an entirely normal response to the well documented demands of performance (Antonini Philippe et al., 2022) and the very real risks of negative evaluation in musical studies and careers: When dependent on the positive opinion of audition panels, colleagues or audiences to pay one's mortgage, fear of evaluation arguably seems not so unreasonable!

3.2.2. MPA as positive

An alternative approach posits that MPA is facilitative and enhances performance by generating extra vitality, excitement, alertness, focus and spontaneity (Hamann and Sobaje, 1983; Nagel, 1993; Roland, 1994; Kantor-Martynuska et al., 2018) (See Gannon (2019) for discussion of how MPA can facilitate performance). This quote by virtuoso Andalusian guitarist Pepe Romero illustrates how experiences commonly associated with anxiety can be experienced positively:

> *"The feeling you get backstage…butterflies in your stomach…your knees shake so much that you can hardly stand, and…you feel like you're about to throw up?? I LOVE that!! It's because we're like a rechargeable battery: those sensations tell us that energy is flowing into our bodies, energy that we need to give to the music and to the audience. So, I don't fight those feelings, I let them flow right into me, and when I step on stage, I let them flow out to the public so that they become energised too!"* (Cited in Helding, 2016, p. 89).

This account only mentions physiological activation, omitting the psychological dimension commonly associated with MPA descriptions (Kenny, 2011). The interaction between performers' physiological and psychological experiences, as well as performers' interpretations of physiological activation seem central to our understanding of MPA, and will be discussed in Section 5. As research has largely focused on debilitating MPA, those who experience MPA positively and/or manage it successfully are underrepresented in scientific literature, highlighting an important gap in current understanding.

3.2.3. MPA as both negative and positive

There have been three key attempts to clarify the debate between MPA as wholly negative or positive. Firstly, conceptualizing MPA as a singular but multi-faceted construct encompassing both adaptive and maladaptive components (Wolfe, 1989). Secondly, viewing MPA as two separate constructs (facilitative and debilitative), although there remains disagreement regarding whether the constructs are distinct (Mor et al., 1995) or exist along a linear continuum (Spahn et al., 2016; Brugués, 2019). Thirdly, delineating MPA (negative) from an entirely different, positive, construct (*'performance energy'*/*'boost'*) describing the performance-enhancing state of anticipation which generates excitement, energy and positive tension (Langendörfer et al., 2006; Nagel, 2010; Simoens et al., 2015). Using one label ('MPA') to define two negatively correlated constructs seems bound to confuse. Indeed, it is difficult to think of any other psychological construct where the same word is used to describe two opposite phenomena. Further research is required to untangle these issues.

3.2.4. MPA as intrinsic to performance

Some researchers shift the focus entirely from performer to performance: Sternbach (1993) refers not to MPA, but instead to the performer's capacity to cope with the anxiety of performing, implying

that performing is inherently stressful and the issue is how individuals manage that stress, a view supported by numerous subsequent researchers including Sataloff et al. (1999), Hays (2009) and Spahn (2015) (Stressors associated with musical performance will be discussed in Section 4.2.3). Brodsky (1996) reconceptualized MPA as pertaining to the nature of a career in music in terms of performance and occupational stress, rather than to personality deficiencies or underlying psychopathology. He offered the alternative label of 'Music-Performers' Stress Syndrome' (M-PSS), including the option of various specifiers (e.g., level of intensity) to reflect the individuality of performers' experiences of MPA. While this seems a valuable contribution to the field, it was never adopted by other researchers. Brodsky additionally proposed a linear continuum of severity moving from 'career stress' at one end, to 'tension in performance' to 'performance anxiety' and finally to 'stage fright' at the other end (see Brodsky, 1996, p. 91). While an interesting perspective, Brodsky does not explain why performers would experience performance stress so dramatically differently, or what delineates the four stages. If stress is intrinsic to performance, it remains unclear what constitutes 'normal' stress and when stress becomes MPA.

3.2.5. Alternative conceptualizations

There have been a few notable recent attempts to offer a completely different perspective on MPA, including Lawrence (2019), who reconceptualizes MPA as performers' unconscious desires manifesting in psychological or somatic form, and Skoogh and Frisk (2019) who investigate MPA from an artistic, rather than psychological, perspective. They theorize that MPA is not an individual problem, but rather a structural issue relating to complex interactions between perfectionism and performance values found in western classical music. While offering real insight, neither has yet impacted the predominantly pathologizing approach to defining MPA.

3.3. Kenny's definition

The definition most widely used today is offered by Kenny (2009):

> *"The experience of marked and persistent anxious apprehension related to musical performance that has arisen through specific anxiety-conditioning experiences and which is manifested through combinations of affective, cognitive, somatic, and behavioural symptoms. It affects musicians for their entire lives and is at least partially independent of years of training, practice, and level of musical accomplishment. It may or may not impair the quality of the musical performance"* (2009, p. 433).

Although this definition is used by most contemporary MPA studies, there are issues worth discussing. Firstly, defining MPA by its *'symptoms'* perpetuates the pathologizing narrative, conjuring up images of illness and disease. As well as the philosophical issues with medicalizing MPA (see Section 7), if it can be facilitative for some, or simply inherent to performance, then the *presence* of 'symptoms' may not be the key issue to understanding or managing MPA.

Secondly, there is no empirical support for the assertion that MPA *"affects musicians for their entire lives."* Are there really no musicians who have managed to overcome it? This argument presumably stems from the issue that MPA studies are pathologically focused, with little account across literature of musicians who successfully manage, or indeed overcome, MPA. Indeed, many studies are fairly cross-sectional, or at least of a limited duration, as opposed to truly long-term, meaning there are minimal (if any) longitudinal data investigating MPA management. Thirdly, MPA is *"at least partially independent of years of training, practice, and level of musical accomplishment."* Given that MPA is reported by individuals of all levels of training, experience and expertise (including celebrated artists such as Chopin, Casals, Rubinstein, Horowitz and Rachmaninoff), MPA can presumably be *entirely*, not *partially*, independent of expertise (Brugués, 2011a; Kantor-Martynuska et al., 2018).

Lastly, the strand "*MPA may or may not impair the quality of the musical performance*" tells us very little about the complex relationship between MPA and performance quality, which will be discussed in Section 5.3. It also omits the impact MPA can have on the *experience* of performing, regardless of whether quality is affected. Across the extensive landscape of MPA literature, a recurring theme is the significant variability with which MPA can manifest, ranging from performance-enhancing, to minimally negative, to debilitating, to career-ending and varying in terms of regularity, performance-setting and manifestation (Nagel et al., 1989; Van Kemenade et al., 1995; Miller and Chesky, 2004; Fehm and Schmidt, 2006; Patson and Loughlan, 2014; Lawrence, 2019). This complexity and multidimensionality is arguably not yet reflected in the prevailing approach to defining MPA.

In sum, the field still lacks a cohesive MPA definition, and we suggest that the main obstacles are (1) terminological and (2) conceptual ambiguities. Regarding terminology – using one term ('MPA') to describe a phenomenon which can be positive, mildly challenging, debilitating or a completely normal part of a performer's life, seems at best unhelpful, at worst deeply problematic. Without a shared language, it becomes impossible to ensure we are all talking about the same thing, which may partially explain the lack of success in supporting musicians to manage MPA – how can we manage a thing effectively without really knowing what that *thing* is? We urgently need a universal MPA definition to be able to effectively support performers experiencing it.

Regarding conceptual ambiguities, although many argue that the majority (if not all) of performers experience apprehension and nerves, and many experience nerves as positive and performance-enhancing (Powell, 2004), efforts to conceptualize MPA as beneficial or intrinsic to performance have been drowned out by the predominantly pathologizing approach (Lawrence, 2019), with significant implications for its perception, experience and management, as will be discussed in Sections 6.2.2 and 7.

Perhaps the issue is not whether MPA is definitively negative, positive or both, but that musicians clearly experience MPA in vastly different ways. The questions then become, what mediate these differences? How can we conceptualize MPA in a way that adequately captures its individuality, complexity and variability and leads to the development of interventions which can support musicians in real and tangible ways? We now turn to MPA's etiology and manifestation in the hopes of addressing these fundamental issues.

4. Etiology

4.1. Theoretical perspectives on MPA's etiology

There is consensus among researchers that MPA is a complex, multidimensional phenomenon produced by the interaction between numerous factors including genetics, biology, environmental stimuli, aversive conditioning experiences, conscious and unconscious anxiety triggers, psychological characteristics and factors relating to musical tasks and performance contexts (Papageorgi et al., 2007; Burin and Osório, 2017; Brugués, 2019). More specifically, there remains debate over which theory best accounts for MPA's etiology. Theories posited (summarized in Table 2) include cognitive theories, behavioral theories, cognitive behavioral theories, physiological theories, psychoanalytic theory and Barlow's Anxiety Model (2000), adapted to MPA by Kenny et al. (2004), Spahn (2015), Altenmüller and Ioannou (2016), Brugués (2019).

While these various theoretical perspectives individually offer insight into specific dimensions of MPA's etiology, none emerges as being comprehensive. Additionally, there is currently no widespread agreement among researchers to support any one theory, all of which lack empirical support (Goren, 2014; Fernholz et al., 2019). While these theories have all contributed significantly to current understanding of MPA (Kenny, 2011), there is a legitimate counterargument that generalizing about MPA's etiology is futile, as its origins vary significantly from person to person (Brandfonbrener, 1990), arguably suggesting a utilitarian, rather than theoretical, approach.

One such utilitarian approach is Wilson's (1994) framework, which divides known MPA risk factors into Person, Task, and Situation. Although this tripartite framework offers a pragmatic heuristic to conceptualize the multitudinous factors contributing to MPA's etiology, two limitations are worth consideration. Firstly, it is clear from the extensive stress literature that it is the individual's interpretation of a stimulus which causes stress, not the stimulus itself (Lazarus and Folkman, 1984). For example, not all musicians reporting similar occupational stressors experience them as equally stressful, or experience similar levels of MPA (Kenny et al., 2004), indicating that stimuli from the Task and Situation domains are subjective and thus filtered through *Person*. Secondly, the three categories are not distinct, but highly interconnected, with complex interactions both within and between domains. Indeed, one domain's impact depends on the level of others (Valentine, 2002). Despite these limitations, this is arguably the best fit available, and has been adopted by subsequent researchers including Valentine (2002) and Burin and Osório (2017).

4.2. MPA risk factors

4.2.1. Person

Person refers to intrapersonal factors which are associated with, and/or predict, MPA, and can therefore be considered risk factors. These include demographic variables (gender and sociocultural factors), biographical details (family, teachers and aversive conditioning experiences), personality traits, cognitive style and comorbid challenges. These factors (see Table 3) appear key to understanding how MPA develops and is sustained (Burin and Osório, 2017). Studies consistently report significant associations between MPA and high levels of maladaptive personality traits including maladaptive coping style (van Fenema et al., 2013; Thomas and Nettelbeck, 2014), low self-efficacy (Sinden, 1999; Liston et al., 2003; Kenny and Ackermann, 2015), maladaptive dimensions of perfectionism (Stoeber and Otto, 2006; Stoeber and Eismann, 2007; Kobori et al., 2011; Sarıkaya and Kurtaslan, 2018; Butković et al., 2022; Yang et al., 2022), low self-esteem (Papageorgi et al., 2007; Burin et al., 2019), negative affect (Zinn et al., 2000; Sadler and Miller, 2010), neuroticism (Langendörfer et al., 2006), susceptibility to anxiety (Stephenson and Quarrier, 2005), guilt/shame-proneness (Coşkun-Şentürk and Çırakoğlu, 2018) and trait anxiety (Osborne and Kenny, 2008; Burin et al., 2019).

Gender (being female) is unequivocally associated with MPA (González et al., 2018; Dobos et al., 2019; Butković et al., 2022), consistent with findings from the general population (de Figueiredo Rocha, 2020). There is also wide agreement that dysfunctional cognitions and cognitive style (rumination, worry, disruptive thoughts, dysfunctional attentional focus, judgmental attitude, catastrophizing and fear of negative evaluation) play a crucial role in MPA's development and sustenance (Kenny et al., 2014; Lupiáñez et al., 2022). A recent study by Sokoli et al. (2022) investigated the extent to which components of MPA (affective, cognitive and somatic) vary according to factors including practice, musical experience, instrument group, gender and age. Their findings of significant associations between age, gender and instrument group and different MPA components, as well as between specific MPA components (anxious feelings and breathing-related complaints) and decrease in self-reported performance quality have important implications for MPA's assessment and management (For further investigations of intrapersonal factors associated with MPA's etiology, see Sadler and Miller, 2010; Burin et al., 2019; Papageorgi, 2020; Wiedemann et al., 2020; Osborne and Kirsner, 2022; Sokoli et al., 2022; Aubry and Küssner, 2023; Kirsner et al., 2023).

As negative personality constructs are associated with MPA, so too are positive ones (Chattin, 2019). Studies have identified several constructs which correlate negatively with MPA including resilience and adaptive coping (Nordin-Bates, 2012; Pecen et al., 2016), openness, conscientiousness and perceived control (Chattin, 2019), positive/realistic cognitive self-statements and performance appraisal (Clark, 1989) and high self-efficacy (González et al., 2018; Sarıkaya and Kurtaslan, 2018; Dempsey and Comeau, 2019). Research is increasingly recognizing the key role of self-compassion in supporting performers across domains – for further discussion, see Baltzell (2016); Kelley and Farley (2019); Lyon and Plisco (2020); Walton et al. (2022). Consistent with the pathological focus of most MPA research, studies largely focus on traits which exacerbate MPA and there is a gap in understanding regarding constructs which protect against MPA. Greater clarity is needed regarding traits and processes which support performers to manage MPA effectively. We turn now to the extrinsic factors associated with MPA's etiology: Task and Situational factors.

4.2.2. Task

Task refers to aspects relating to performance tasks: technical insecurities that cause uncertainty and/or physical tension at the

TABLE 2 Summary of key psychological theories explaining MPA's etiology.

Cognitive theories	Cognitive theories emphasize the centrality of dysfunctional cognitions in the development and maintenance of MPA and their impact on physiology, emotions and behavior (Spahn, 2015).
Behavioral theories	Behavioral models conceptualize MPA as a classically conditioned fear attributed to traumatic learning experiences during performers' formative years which lead to the development of maladaptive cognitions and behaviors (Clark, 1989; Spahn, 2015; Altenmüller and Ioannou, 2016). Different responses to similar learning experiences can be attributed to genetic/factors (Kenny, 2011).
Cognitive behavioral theories	Cognitive behavioral psychologists attribute MPA to negative cognitions and self-beliefs that undermine preparation and self-confidence (Altenmüller and Ioannou, 2016; Brugués, 2019), particularly catastrophizing and attention binding (Beck and Clark, 1988). The distinction between cognitive theories and cognitive behavioral theories of MPA remains unclear (Kenny, 2011).
Physiological theories	Physiological psychologists primarily attribute MPA to humans' evolutionary stress response whereby perception of threat triggers a range of physiological reactions known as the fight/flight response. Modern threats include failure, humiliation, exposure and disappointing significant others/peers (Spahn, 2015; Altenmüller and Ioannou, 2016).
Psychoanalytic theory	According to psychoanalytic perspectives (including attachment theory), MPA symptoms arise from individual childhood experiences, including attachment with caregivers, and express conscious or unconscious internal conflicts (Kenny, 2011; Spahn, 2015). In this modality, the audience represents parental figures; fear of negative evaluation reflects feared loss of parental love. Unconscious fears manifest in negative cognitions and fears of losing control (Spahn, 2015). There remains minimal empirical support for this theoretical perspective (Brugués, 2019).
Barlow's Anxiety Model (2000)	Kenny et al. (2004) adapted Barlow's (2000) tripartite Anxiety Model to MPA, and this model has underpinned Kenny's subsequent work on MPA. This adapted theory attributes MPA to the interaction between three dimensions of vulnerability: biological (personality traits), general psychological (early learning experiences) and specific psychological vulnerabilities (learned anxiety in response to specific environmental stimuli) (Barlow, 2000; Kenny, 2011; Gembris and Heye, 2012) Although the most comprehensive of these theories, the distinction between biological and learned traits seems somewhat arbitrary in terms of relevance for musicians seeking to manage MPA. While traits may be relatively stable, research shows their malleability, which problematizes classifying traits as biological.

instrument, insufficient preparation, difficulty of repertoire/attempting repertoire beyond one's ability interpretation of the score, and memorization worries (Kenny et al., 2014; Burin and Osório, 2017; Burin et al., 2019; Ginsborg, 2019). All of these factors are regularly cited by performers as key causes of MPA (Burin et al., 2019). However, they are all highly subjective and thus arguably mediated through *Person.*

4.2.3. Situation

Situation can be divided into factors relating to performance mode and to occupational stressors. Within performance mode, solo performance is more associated with MPA than ensemble performance (Brugués, 2019) and public performance and auditions are more associated with MPA than rehearsal or practice (Yoshie et al., 2009; Brugués, 2019). Occupational stressors include the following:

- Social and environmental conditions (Antonini Philippe et al., 2019)
- Financial insecurity (Dobson, 2011; Gross and Musgrave, 2016; Brugués, 2019)
- Job uncertainty (uncertainty about regular employment, highly competitive industry) (Sousa et al., 2016; Brugués, 2019; Burin et al., 2019)
- Demanding work schedule (irregular, unpredictable and anti-social hours, long hours of rehearsal, grueling tour schedules, travel, jetlag) (Burin and Osório, 2017; Brugués, 2019)
- Separation from family (Vervainioti and Alexopoulos, 2015; Sousa et al., 2016; Brugués, 2019)
- Demands of 'professional sociability' (especially for freelancers), associated with 'alcohol as career facilitator' (Dobson, 2011; Brugués, 2019)
- Environmental challenges (venue): unfamiliar halls, generally unsatisfactory/challenging performance conditions, suboptimal acoustics, temperature, poor seating, lighting and unsafe or cramped backstage, audience characteristics (Parasuraman and Purohit, 2000; Papageorgi et al., 2007)
- Interpersonal challenges: comparison/competition with peers, lack of artistic control/integrity, social tensions (problems with stand partner, back-stabbing between colleagues, lack of confidence in colleagues, issues with management, perceived lack of support from significant others), critical (abusive) verbal style of conductors and frequent changes in leadership (conductor) requiring constant adaptation to different personalities/musical styles (Parasuraman and Purohit, 2000; Burin et al., 2019)
- Performance pressures: scrutiny from audiences, critics & colleagues [managing unrealistic standards of perfection (Kenny, 2004; Dobson, 2011; Burin and Osório, 2017)]

Numerous studies have shown associations between occupational stress and MPA, indicating that they are not independent domains (Voltmer et al., 2012; van Fenema et al., 2013). Based on their qualitative systematic review, Vervainioti and Alexopoulos (2015) concluded that the occupational stressors facing musicians are highly interconnected, forming a complex web between MPA and factors intrinsic and extrinsic to the performer. Across the literature, almost all professional musicians report occupational stress, and many cite it as a key contributor to MPA (Kenny et al., 2014).

While the nature of the association between MPA and situational factors is not entirely clear, there are several plausible links. Given the significance of fear of negative evaluation in predicting MPA, it is unsurprising that performance modes with

TABLE 3 Intrapersonal factors associated with MPA.

Demographics	Gender	There is broad consensus that women of all ages experience MPA more widely and acutely than men (consistent with generalized anxiety) and that gender is a significant factor in predicting MPA (Papageorgi et al., 2007; Thomas and Nettelbeck, 2014; Burin and Osório, 2017; Fernholz et al., 2019).
	Sociocultural factors	James (2000) reported significant differences in the quantity of stress experienced from occupation-related stressors across different nationalities. No explanation was given to account for sociocultural differences. Based on his study investigating levels of self-esteem among American, Australian and Chinese music students, Brand (2004) concluded that self-perception and self-esteem differ across cultural groups. His findings indicate the importance of cultural differences in understanding the development, as well as the prevention and treatment, of MPA. Unfortunately, as no further studies have been conducted in this area (Brugués, 2019), understanding of this important topic remains minimal. This represents an important gap in understanding, as all *person* relationships to MPA are arguably culturally conditioned. Mumm et al. (2020) suggest that transcultural differences should be taken into account when diagnosing and treating MPA in musicians from different cultural backgrounds, such as individualistic versus collectivistic societies.
Biography factors	Family & Teachers	Influence of parental expectations (pressure), severity of pedagogical style and pressure from teachers (Brugués, 2019; Burin et al., 2019). See Kenny and Holmes (2015, 2018) and Wiedemann et al. (2020) for detailed discussion regarding the complex relationship between parenting and attachment style and MPA.
	Conditioning	Aversive experiences from past performances causing conscious or unconscious anxiety-triggers (Kenny, 2006; Osborne and Kenny, 2008; Burin et al., 2019). Negative experiences arguably increase the chance of perceiving performance situations as threatening, increasing the likelihood of MPA symptoms manifesting.
Personality traits	Coping style	Inadequate, or maladaptive, coping strategies significantly predict MPA (Sinden, 1999; van Fenema et al., 2013; Thomas and Nettelbeck, 2014); Difficulty coping with performance-related arousal and negative cognitions perceived as contributors to MPA (Burin et al., 2019).
	Self-efficacy	Several studies have shown a positive correlation between low self-efficacy and MPA (Sinden, 1999; Liston et al., 2003; Papageorgi et al., 2010) and a negative correlation between high self-efficacy and MPA (Craske and Craig, 1984). The significant association between self-efficacy and anxiety has been attributed to the interaction between low confidence in one's ability to execute a task and physiological, psychological and behavioral anxiety symptoms (Bandura, 1991).
	Perfectionism	Previously thought to be a unidimensional construct, perfectionism is now defined as a multidimensional personality trait characterized by setting exceedingly high personal standards in search of flawless performance and tendencies toward overly critical self-evaluations (Hewitt and Flett, 1991). Perfectionism comprises both adaptive and maladaptive components – adaptive elements (perfectionistic strivings) are associated with positive behaviors, intrinsic motivation and achievements whereas maladaptive elements (perfectionistic concerns) are associated with negative behaviors and outcomes including excessive worry about making mistakes, self-doubt and negative responses to perceived failures or imperfections (Hewitt and Flett, 1991; Frost et al., 1993; Mor et al., 1995; Sinden, 1999; Stoeber and Otto, 2006; Stoeber and Eismann, 2007). Dimensions of maladaptive perfectionism are associated with depression, anxiety, excessive self-criticism, low self-esteem, disordered eating, maladaptive cognitions, performance dissatisfaction, fear of negative evaluation and burnout (Hewitt and Flett, 1991; McGrath, 2012; Zhukov, 2019). Studies of musicians reveal negative dimensions of perfectionism to strongly predict MPA as well as extrinsic motivation and psychological distress (Stoeber and Otto, 2006; Stoeber and Eismann, 2007; Kobori et al., 2011; Diaz, 2018). Pressure from self, associated with excessively high standards, is one of the most frequently cited causes of MPA (Kenny et al., 2014; Burin et al., 2019). The relationship between perfectionism and MPA is highly complex because both phenomena are multi-faceted and encompass both positive and negative dimensions, and because the relationship can be mediated by third variables, such as self-efficacy (Mor et al., 1995).
	Low self-esteem	Low self-esteem is associated with the prediction of MPA (Sinden, 1999; Papageorgi et al., 2007; Chan, 2011; Kenny et al., 2014; Burin et al., 2019). Musicians invest highly in their identity as performers and often struggle to disentangle their self-esteem from their musical competence – the perception that 'failing' in performance equates to failing as people increases performers' vulnerability to anxiety (Sinden, 1999; Kenny, 2009).
	Negative affect	Studies have reported significant associations between negative affect and MPA (Zinn et al., 2000; Sadler and Miller, 2010), although the direction of this association is unclear.
	Neuroticism	Neuroticism and MPA are strongly associated (Valentine et al., 1995; Langendörfer et al., 2006; Thomas and Nettelbeck, 2014).
	Susceptibility to anxiety	Susceptibility to anxiety refers to an individual's pattern of perceiving situations and anxiety symptoms as threatening or dangerous, and is a significant predictor of MPA, especially among women (Stephenson and Quarrier, 2005; Kenny, 2011; Burin and Osório, 2017).

(Continued)

TABLE 3 (Continued)

	Trait anxiety	Anxiety is universally conceptualized as two-dimensional, comprising both state and trait elements – state anxiety is defined as a transient emotional state characterized by nervousness, apprehension, stress and heightened tension, whereas trait anxiety is a relatively stable personality characteristic whereby individuals tend to perceive situations as threatening (Spielberger, 2013; Brugués, 2019). The two dimensions are not independent – trait anxiety intensifies state anxiety and high trait anxiety predicts high state anxiety (Hamann, 1985; Kenny, 2011; Rumsey, 2015). Numerous studies report significant associations between trait anxiety and MPA (Hamann, 1982; Craske and Craig, 1984; Steptoe and Fidler, 1987; Lehrer et al., 1990; Cox and Kenardy, 1993; Kenny, 2004; Langendörfer et al., 2006; Burin et al., 2019) with some studies concluding trait anxiety is one of the strongest predictors of MPA (Smith and Rickard, 2004; Osborne and Kenny, 2008; Thomas and Nettelbeck, 2014). In their study of MPA and its anxiety correlates, Wiedemann et al. (2021) found Generalized Anxiety Disorder (GAD) to be the strongest predictor of MPA. One study seeking to explain the relationship between trait anxiety and MPA found that lower trait anxiety was positively correlated with participants perceiving their anxiety symptoms as non-detrimental to performance quality (Cox and Kenardy, 1993). Ruggiero (2012) found A-trait to be the only significant predictor of performance difficulties (self-reported), once gender had been controlled for. As well as predicting MPA, A-trait has been found to moderate the interaction between A-state and performance-related behavioral outcomes. Reducing trait anxiety could have real implications for managing MPA.
Cognitive style	Negative cognitions/ cognitive style	Cognition arguably forms MPA's primary component, with negative cognitions predicting MPA more than physiological, emotional or behavioral components (Miller and Chesky, 2004; Kenny, 2006). Studies show significant differences in the cognitions and cognitive styles of highly anxious, compared to low anxious, musicians (Burin and Osório, 2017), with maladaptive cognitive styles contributing to the development and sustenance of MPA (Osborne and Kenny, 2008). The cognitions of anxious musicians can be characterized by recurrent thoughts about negative past performances, imagined avoidance behavior, excessive focus on physiological cues, worrying about not being able to manage physiological arousal or manage negative thoughts, strongly negative self-evaluative focus, irrational beliefs (such as *"I must be perfect"*), expectations of negative evaluation from others, preoccupation with the consequences of suboptimal performances, catastrophizing, inability to manage negative cognitions (self-talk), perceptions of performances as threatening, and general worries about performing (Fehm and Schmidt, 2006; Clark et al., 2014; Kenny et al., 2014; Burin et al., 2019). According to one study (Lehrer et al., 1990), worry is the cognitive factor most significantly correlated with debilitating MPA. The diversion of mental energy to worrying is closely linked to disruption of attention from performance-related tasks (Osborne and Kenny, 2008); distraction and inability to focus are frequently cited as major sources of MPA (Steptoe, 1982; Grindea, 1984; Reubart, 1985; Talbot-Honeck, 1994). Conversely, positive (or realistic) thinking and MPA are negatively correlated (Steptoe and Fidler, 1987; Clark, 1989). Multiple regression analyses of MPA's correlates showed cognitive factors to be the key predictor of MPA as they underpin all the other factors correlated with MPA in bivariate statistical analysis (catastrophizing, low self-esteem, low self-efficacy, trait anxiety, and maladaptive perfectionism) (Liston et al., 2003).
	Rumination	Negative post-event rumination (PER) is associated with increased MPA levels and decreased enjoyment of performance, with PER decreasing less quickly post-performance in high anxious compared to low anxious participants (Nielsen et al., 2018). Little research has been conducted investigating the relationship between PER and MPA, but these findings are consistent with research on general anxiety and indicate the association between PER and general anxiety.
	Judgmental attitude	Excessive self-criticism in practice and on stage, as well as absolutist judgments regarding one's behavior, can predict and exacerbate MPA (Lehrer et al., 1990; Sternbach, 2008).
	Catastrophizing	Catastrophizing is a key predictor of MPA (Steptoe and Fidler, 1987; Zinn et al., 2000), with one study finding it to be the single most powerful predicting variable (Liston et al., 2003). While catastrophizing self-statements correlate with high MPA, realistic cognitive self-statements and appraisal of performance correlate with medium levels of MPA (Steptoe and Fidler, 1987), indicating the importance of self-talk.
	Fear of negative evaluation	Fear of negative evaluation (the disapproval of peers, teachers, colleagues, audiences and critics) is a core component of, and significantly predicts, MPA (Papageorgi et al., 2010; Nicholson et al., 2015; Kantor-Martynuska et al., 2018; Burin et al., 2019; Zhukov, 2019). Studies show increased MPA in evaluative versus non-evaluative performing situations (Kobori et al., 2011; Mitchell, 2011), which is problematic given the evaluative nature of professional music-making.
Comorbidities	Psychological issues	Research indicates that musicians' mental health is an issue of serious concern – studies show that musicians report significantly higher levels of anxiety and depression than the general population (Barbar et al., 2014; Kenny et al., 2014). According to their study of over 2000 UK-based musicians, 71.1% of respondents had experienced panic attacks and/or serious anxiety and 68.5% reported depression (Gross and Musgrave, 2016). The majority of survey respondents ranged between 18–35 years, indicating the scale of the problem among the next generation of musicians. Studies consistently show significant correlations between MPA and a range of psychological challenges including depression, generalized anxiety, stress and substance abuse (alcohol and non-prescription drugs) (Vervainioti and Alexopoulos, 2015; Gross and Musgrave, 2016; Wiedemann et al., 2021). Musicians experiencing high levels of MPA are statistically more likely to experience these comorbid challenges (Burin et al., 2019).

(Continued)

TABLE 3 (Continued)

	Physical issues	Research indicates that 55–86% of musicians experience playing-related physical problems severe enough to affect their performance (Kenny et al., 2016; Burin and Osório, 2017; Gembris et al., 2018). These challenges include headaches and stomachaches (Kivimäki and Jokinen, 1994), fatigue and sleep disturbances (Halleland et al., 2009; Dobson, 2011; Voltmer et al., 2012), chronic back pain (Brandfonbrener, 1986), peripheral nerve problems (e.g., focal dystonia) (Schuele and Lederman, 2004), hearing impairment (tinnitus/hearing loss) (Brandfonbrener, 1986; Harper, 2002; Gembris et al., 2018; Topoğlu et al., 2018), and Performance-Related Musculoskeletal Disorders (PMRDs), arising from excessive training, repetition and fatigue and manifesting in pain, numbness, tingling, weakness and other symptoms which disturb high-level performance (Schuele and Lederman, 2004; Voltmer et al., 2012; Vervainioti and Alexopoulos, 2015; Gross and Musgrave, 2016; Topoğlu et al., 2018). The MPA-pain relationship could be explained by performers experiencing psychological distress in response to injuries (Spahn, 2002), that fewer symptoms of pain and fatigue predict higher quality practice and performance (Kreutz et al., 2008; Ginsborg et al., 2009) or that the physiological dimension of MPA causes muscular tension, overstressing the body's locomotor system causing overuse injuries (Hildebrandt et al., 2012; Rumsey, 2015). Physical challenges are often rated as a cause of MPA by performers (Burin et al., 2019).

greater exposure (solo performance and public performance/auditions) are more associated with MPA than those with lower exposure (ensemble performance and rehearsal/practice). Regarding occupational stressors, these are largely beyond performers' control (Clark et al., 2014), which may contribute to a sense of anxiety. As discussed, all stimuli are filtered through the individual, which could explain why highly anxious musicians are more likely to experience occupational stressors as stressful (Steptoe, 1989). While occupational stressors are inherent to the profession and therefore cannot be removed, protecting musicians from their negative impact will arguably be easier with greater understanding of the mechanisms underpinning the relationship between them and MPA. Seemingly, coping effectively with MPA could reduce the stress of occupational stressors and vice versa. Please see Gross (2015) for discussion of the interaction between emotion regulation, coping and emotional experience.

In sum, MPA is broadly viewed within a multi-factor model, where the degree of anxiety experienced depends on the interaction between a constellation of factors intrinsic and extrinsic to the performer, including biological and demographic variables, personality constructs, and task-based/situational factors associated with musical performance (Antonini Philippe et al., 2022). We turn now how and why MPA manifests, and how it can affect performance and/or performer.

5. MPA manifestation and impact

5.1. Why MPA manifests

MPA comprises a constellation of partially independent yet interactive responses to perceived threat (Kenny, 2006). In very basic terms, the amygdala constantly scans our environment for threat; when it interprets sensory information as threatening, it triggers the release of stress hormones adrenaline (from the sympathetic nervous system, SNS) and cortisol (via the hypothalamic–pituitary adrenal (HPA) pathway), activating a range of physiological responses which maximize the body's capacity to deal with the threat (McCarty, 2016). This phenomenon, known as the fight or flight response (Cannon, 1927) can be triggered consciously or unconsciously (Kenny, 2006). Performers vary in their response to anxiety-provoking stimuli for a wide range of reasons including aversive performance experiences (particularly during formative years) (Osborne and Kirsner, 2022) and the intrapersonal factors discussed in Section 4.2.1 which may exacerbate individuals' perception of a performance as threatening, thus triggering, as well as sustaining, MPA.

The fight or flight response seemingly evolved to protect humans from physical threat endangering their survival. However, the amygdala has not yet evolved to distinguish between physical and psychological threats and triggers the same alarm system in response to both (Kenny, 2011), which is why performing a Mozart concerto can elicit the same physiological response as encountering a tiger. Barlow (2002) differentiates between 'true alarms' (automatic physiological activation in response to real danger) and 'false alarms' (learned fear responses triggered in the absence of real danger). In the case of true alarms, such as fleeing a burning building, the fight/flight response is vital to survival. However, in the case of false alarms (psychological threats), excessive SNS activity can be problematic, interfering with the fine motor skills necessary for musical performance and potentially creating emotional distress (Kenny, 2009).

Numerous theories have sought to explain what causes so-called 'false alarms', including classic operant conditioning (anxiety-conditioning experiences), vicarious (observational) learning, heightened neurobiological hyperreactivity, and psychoanalytic theories, where the audience represents parents or other significant caregivers (Kenny, 2009). While no account is comprehensive, and causes are most likely multi-determined (Kenny, 2009), it seems clear that a prerequisite for MPA to manifest is the performer's initial perception of a stimulus (performance) as threatening (Osborne and McPherson, 2019).

5.2. How MPA manifests

5.2.1. Physiology

Physiological responses to perceived threat include increased cardiovascular activity (tachycardia, palpitations and increased blood pressure), respiratory changes (hyperventilation, difficulty controlling breathing, and shortness of breath), dry mouth, throat constriction (difficulty swallowing), blurred vision, perspiration and clamminess, hot or cold flushes, dizziness, urinary urgency, gastrointestinal activity (butterflies, nausea, vomiting, upset stomach, diarrhea), excessive

muscle tension and fatigue, reduced motor control, coordination and agility, muscle spasms/tremor, transient limb paralysis, uncontrollable shaking, numbness or tingling in extremities and hormonal changes (Spahn, 2015; Altenmüller and Ioannou, 2016; Guyon et al., 2020; Turan et al., 2022). Excessive muscular tension is particularly problematic as it can disrupt the fine motor control required for performance and increase risk of PMRDs (Yoshie et al., 2009; Pell, 2020; Vivas et al., 2021). Given the unpleasantness of these experiences, it is unsurprising that controlling them is often the most urgent goal for performers (Zhukov, 2019).

Although physiological data are often used to assess MPA level, evidence to support their use as a proxy for MPA is equivocal (Yoshie et al., 2009). Indeed, research shows that performers with significantly elevated heart rate and blood pressure can report low MPA while performers showing normal physiological parameters can report intense MPA and that physiological arousal often correlates positively with optimal performance (Craske and Craig, 1984; Spahn et al., 2010; Endo et al., 2014; Studer et al., 2014). These findings suggest that physiological activation seemingly becomes problematic only when met with/experienced alongside psychological distress – the importance of negative cognitive appraisal in generating and exacerbating MPA arguably cannot be understated (Steptoe, 2001; Osborne and Kenny, 2008). We therefore turn now to the psychological components of MPA.

5.2.2. Cognitions

Research consistently indicates the prominence of dysfunctional cognitions in highly anxious performers (Kenny and Osborne, 2006; Sokoli et al., 2022). While cognitions are generally discussed as one dimension, it may be helpful to divide them into two discrete (albeit somewhat overlapping) categories: cognitive content (specific worries) and cognitive style (type of thinking). *Cognitive content* (worries), centered on the perceived threat of risk or danger (Salmon, 1990) include worrying about memory lapses, errors, technical or musical incompetence, negative evaluation, failure, embarrassment or humiliation, and inability to control the effects of physiological arousal (McGrath, 2012; Fernholz et al., 2019). Although cognitions are often discussed as a response to physiological activation, they can also be part of the initial anxiety response – anxiety distorts cognitive style and constricts thinking, manifesting in a maladaptive *cognitive style* characterized by irrational and self-defeating failure-focused cognitive patterns (Osborne and Franklin, 2002; Altenmüller and Ioannou, 2016).

A fundamental aspect of MPA seems to be the disruption of task-oriented cognitions – Steptoe (2001) identifies three key types of disruption: (1) catastrophizing (exaggerating the probability and impact of negative/disastrous events in performance) which is strongly positively correlated with MPA (Valentine, 2002), (2) preoccupation with possible negative evaluation, and (3) heightened perception of physiological changes and interpreting them as indicating loss of control and inevitable collapse. Other maladaptive cognitive styles include negative self-talk (excessive focus on perceived inadequacies), irrational beliefs (such as conflating one's performance with one's self-worth), excessive focus on task-irrelevant thoughts provoked by internal or external distractions and rumination (self-doubts, negative and judgmental thoughts about oneself and one's performance, projected criticism from the audience and excessive focus on technical inadequacies) (Perdomo-Guevara, 2014; Spahn, 2015; Zhukov, 2019). Anxious cognitions can impair concentration and focus, drain self-confidence and interfere in the creative process (McGrath, 2012; Patson and Loughlan, 2014). *In extremis*, negative post-performance rumination can resemble post-traumatic stress disorder (Sternbach, 1993).

5.2.3. Emotions

The fundamental experience of anxiety is arguably anxious apprehension– a future-based state characterized by feelings of helplessness based on the sense that one can neither predict nor control possible threats (Kenny, 2009). Other commonly reported emotions associated with MPA include dread, fear, panic, terror, stress, insecurity, irritability, anger, moodiness, embarrassment, denial, depression, distress, shame, frustration and guilt (McGrath, 2012; Spahn, 2015; Kantor-Martynuska et al., 2018; Fernholz et al., 2019).

5.2.4. Behaviors

Behavioral responses encompass a range of conscious and unconscious behaviors such as overt physical expressions of anxiety (alterations in body language such as postural distortions, tensed or hunched shoulders and distressed or deadpan facial expressions) (Patson and Loughlan, 2014), isolation from others (Roland, 1994), avoidance behaviors (Lederman, 1999; Fernholz et al., 2019) such as avoiding practicing difficult technical passages (Lehrer and Woolfolk, 1982), or performance avoidance (Salmon, 1990), and general unrest (agitation, fidgetiness, escapist tendencies) (Steptoe, 2001; Spahn, 2015). Performers may also engage in 'safety behaviours' such as alcohol or drug consumption, distraction techniques (Fernholz et al., 2019) and compulsive, ritualized, behaviors such as repetitive practice, repeatedly checking instrument or moistening lips (Patson and Loughlan, 2014; Spahn, 2015; Altenmüller and Ioannou, 2016). It is unclear whether these behaviors are manifestations of MPA, coping strategies to manage MPA, or both. We turn now to MPA's impact on performance quality, an issue of paramount importance to musicians (Kenny, 2011).

5.3. How does MPA impact performance quality?

Numerous theories have sought to explain the complex relationship between anxiety (or arousal) and performance quality across a range of domains. The first, and most widely used, is the Yerkes and Dodson (1908) 'Inverted U', which posits that performance quality is highest when arousal is moderate; below or above this optimal functioning zone, performance quality decreases (Williamon, 2004). Although this relationship seems well-established, it only considers physiological arousal, rendering it overly simplistic. Fazey and Hardy's (1988) Catastrophe Theory adds a third dimension – cognition – arguing that the Yerkes-Dodson Law holds when cognitive anxiety is low, but when cognitive anxiety is high, the quality of performance can deteriorate catastrophically (Hardy and Parfitt, 1991). For detailed discussion of the Yerkes-Dodson and Catastrophe Models across performance domains, see Ruggiero (2012).

The last two decades have seen the development of models which focus specifically on the relationship between MPA (as opposed to arousal/performance anxiety in other domains) and performance quality (Zinn et al., 2000; Kirchner, 2003; Papageorgi et al., 2007; Chow and Mercado, 2020; Osborne and Kirsner, 2022). Collectively, these five models, summarized in Table 4, illuminate different aspects

TABLE 4 Models exploring how MPA disrupts performance.

Zinn et al. (2000)	Zinn et al.'s (2000) Psychophysiological MPA model attributes MPA to physiological manifestation of repressed anxiety; performance quality is impaired through errors caused by SNS overactivation.
Kirchner (2003)	Based on her qualitative study investigating MPA in solo pianists, Kirchner (2003) proposes a model wherein MPA is initially triggered by threat, and then manifests in cognitive, emotional and physiological responses which interact, both with each other, and with the performer's identity. This model clearly shows the circularity of MPA – each domain interacts with the others, rendering the cycle difficult to stop once in motion.
Papageorgi et al. (2007)	Papageorgi et al. (2007) offer a conceptual framework of MPA, which maps out comprehensively out the different temporal stages of MPA's trajectory, from intrapersonal, task and environmental factors, to the performer's evaluation of the performance context, through the performance to post-performance conditions.
Chow and Mercado (2020)	Chow and Mercado (2020) critique existing psychological MPA theories based on an overreliance on relating a performer's physiological and psychological state to their capacity to maintain focus and execute learned skills, without accounting for how past experience and task-specific expertise moderate the intensity of anxiety experienced in performance. The authors propose a Connectionist Model in which MPA is co-determined by experience-dependent plasticity, cognitive and physiological states and competition between motivational systems. The model offers valuable insight into how experience-dependent plasticity may contribute to the development of socio-evaluative anxiety in pressurized situations.
Osborne and Kirsner (2022)	The most recent MPA model (Osborne and Kirsner, 2022) illustrates how relevant past experiences interacting with maladaptive schemas and low self-efficacy to distort a musician's perception of the likelihood and consequences of negative evaluation in highly evaluative performance situations. In performance, physiological and attentional changes interact to produce performance problems, which can either lead to coping strategies enabling the performer to re-engage in performance, or to disengagement or avoidance.

of the complex and multidimensional relationship between MPA and performance quality and contribute significantly to current understanding. We will now suggest four areas for possible further exploration.

5.3.1. Performers who experience MPA yet do not demonstrate performance problems

The Yerkes-Dodson 'inverted U' has underpinned academic discussion of anxiety's impact on performance quality across domains for over a century, leading to the widely held perception that performance quality deteriorates beyond a certain level of anxiety. However, evidence to support this is not clear-cut (Osborne et al., 2020). Despite evident cognitive differences between low and high anxious performers, highly anxious performers do not necessarily display impaired performance (Kenny, 2004; Kantor-Martynuska et al., 2018). In their study of professional orchestral musicians, Kenny et al. (2014) found that even the most highly anxious performers rarely experienced performance catastrophes, or indeed any significant impairment of performance quality. Indeed, numerous renowned artists (including Pablo Casals, Steven Osborne, Vladimir Horowitz, Maria Callas and Andrea Bocelli) have publicly disclosed their personal struggles with MPA, while maintaining highly successful musical careers. From their continued critical acclaim, one can reasonably infer that they managed to perform to a consistently high level, despite self-reported debilitating anxiety, seemingly refuting the premise that excessive arousal causes performance deterioration.

It seems that musicians can perform to high levels of excellence while experiencing significant levels of MPA, but that their wellbeing and enjoyment of performance can still suffer (Kenny, 2011). This suggests that (1) existing models account for MPA's impact on performance, but not performer, and (2) that further research is needed to understand which variables or processes moderate the relationship between MPA and performance quality.

5.3.2. The interaction between MPA responses

Only one of the models (Kirchner, 2003) unpacks the interaction of MPA responses. As cognitions underlie behaviors and interact reciprocally with emotions and physiology (Valentine, 2002; Perdomo-Guevara, 2014), negative cognitions can trigger interaction between all four domains, creating a vicious circle whereby responses 'feed off' each other and can become overwhelming and difficult to manage (De Felice, 2004; Oyan, 2006; Kenny, 2011). Wolfe (1989) offers the example of a flutist experiencing dry mouth, whose worries about dry mouth exacerbate dryness and increase anxiety, in turn exacerbating dry mouth and so on. Seemingly, the interaction *between* responses may offer a more useful way to understand their impact than their *presence*. While interaction between MPA responses seems key to understanding its impact, the relational aspect of responses is under researched (Stanson, 2019) and prevailing theories are not addressing adequately how interaction works, or how it can be effectively managed to mitigate its impact on performance.

5.3.3. Performers' interpretations of MPA

Research in both music and sport indicates that anxiety is multidimensional, with intensity and direction of symptoms forming distinct constructs (Jones and Swain, 1992; Mor et al., 1995; Miller and Chesky, 2004). Growing evidence suggests that performers' interpretation (cognitive appraisal) of anxiety impacts performance significantly more than its presence (Osborne and Kenny, 2008; Clark et al., 2014; Osborne and McPherson, 2019; Osborne and Kirsner, 2022), with facilitative interpretations enhancing performance and debilitative interpretations leading to decreased enjoyment of performing and deleterious effects on performance quality (Yoshie et al., 2009). Performers' interpretation of MPA as positive or negative is seemingly mediated by a range of factors including performing experiences, task mastery, self-efficacy and perceived control over anxiety symptoms (Osborne and Kirsner, 2022).

Research investigating performers' interpretations of MPA has largely focused on the positive/negative binary. However, acceptance (versus resistance) may offer an alternative framework to understand performers' interpretations of MPA, and its impact on performance. Anxiety-related psychopathology is characterized by experiential avoidance of fear (Schanche et al., 2020), whereas psychological acceptance correlates positively with improved coping strategies (Baer, 2003) and negatively with emotional dysregulation and other indices of poor mental health (Hitchcock et al., 2016). The consistent findings that performers' response to MPA has greater impact than its presence has important implications for understanding how MPA can impact performance and the 'response' stage should arguably be a critical component in MPA models.

5.3.4. MPA and attentional focus

> *"My experience is what I attend to"* [William James, cited in Tremayne and Morgan (2016), p. 389].

Across domains, optimal performance demands intense concentration and focus (Talbot-Honeck, 1994). Indeed, within musical performance the centrality of attention regulation has long been recognized (Rife et al., 2000; Kenny, 2011). One of MPA's most common and challenging effects is attentional changes – both the narrowing of focus (Valentine, 2002) and the shift in focus from task-relevant to task-irrelevant, manifesting in negative self-evaluation, worries, rumination and preoccupation with physiological changes (Liston et al., 2003; Kenny, 2011). Essentially, anxiety hijacks attention from the music (Salmon and Meyer, 1992; Oyan, 2006). Humans have finite attentional capacity (Kantor-Martynuska et al., 2018) – when attention is both constricted by anxiety and depleted attentional resources are hijacked by negative cognitions, there is insufficient bandwidth to focus on task-relevant processes, which can impair performance, in turn exacerbating physiological, cognitive and emotional responses (Kenny, 2009).

Attentional Control Theory (ACT, Eysenck et al., 2007) offers a compelling account of the complex relationship between attentional focus and performance quality. According to this extramusical theory, anxiety decreases attentional control and processing efficiency by overloading working memory with anxious cognitions and increased focus on threat-based stimuli, thus impairing executive function. Eysenck and Calvo (1992) and Eysenck et al. (2007) differentiate between effectiveness and efficiency in performance: *effectiveness* refers to performance quality, and seems independent of anxiety, while *efficiency* (the interaction between effectiveness and deployment of personal resources) is impaired by anxiety as negative cognitions disturb task-relevant processing. When anxiety induces performers to deploy compensatory strategies/resources, performance effectiveness (quality) overall will not be impaired.

This finding is significant as it arguably explains how experience and expertise can mediate MPA's impact on performance quality – the elite performers discussed above may have sufficient resources to enhance their efficiency, thus maintaining high levels of performance effectiveness. This may also explain why performers can perform to very high levels, but at a high personal cost in terms of their wellbeing and reduced enjoyment of performance. Studies have been conducted using ACT to predict anxiety-related performance outcomes across domains cognitive performance (Eysenck et al., 2007), athletics (Causer et al., 2011) and music performance (Ruggiero, 2012). A study by Oudejans et al. (2017) found that music students experienced a significant increase in self-reported negative cognitions immediately before choking (crumbling under pressure), suggesting that anxiety-induced attentional changes may cause performance deterioration in less expert/experienced performers. In their study comparing external versus internal focus conditions, Mornell and Wulf (2019) found increased musical expression and technical accuracy in the external focus group. Collectively, these studies suggest that planning and training particular attentional foci could optimize learning and performance outcomes. Further research applying ACT to musical performance could offer valuable insight into the different constructs of effectiveness and efficiency, and help performers navigate the challenges associated with reduced bandwidth under pressure.

In sum, we suggest that developing a comprehensive MPA model requires further insight into (1) understanding performers who experience MPA yet do not demonstrate performance problems, (2) the nature of the interaction between MPA responses, (3) how performers' interpretation of their experience impacts performance and (4) the relationship between attentional changes and performance quality/experience. We turn now to the ways in which musicians seek to manage MPA.

6. Managing MPA

Given the myriad ways MPA can threaten performance, it is unsurprising that musicians utilize a range of strategies to try and mitigate its impact. This section will discuss the two routes musicians take to manage MPA: Coping strategies and interventions. Coping here encompasses the conscious/unconscious application of behaviors/strategies musicians employ to manage MPA; interventions here are more formalized programs based on the explicit training of specific strategies to manage MPA, delivered by a trained practitioner. As these two topics are qualitatively different, they will be presented separately.

6.1. Coping with MPA

Coping is defined as the "constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus and Folkman, 1984, p. 141). There is broad consensus that it is not the type or quantity of stress that determines its impact, but how the individual copes with stress (Lazarus, 2006). While there is agreement regarding what coping is, the models used to categorize coping strategies vary across the literature. Distinctions include adaptive versus maladaptive, effective versus ineffective (Wolfe, 1990), problem-orientated versus emotion-orientated (Studer et al., 2011), appraisal versus avoidance (Langendörfer et al., 2006), cognitive versus behavioral (Burin and Osório, 2017), and trait versus state (Langendörfer et al., 2006). The aim of this discussion is not to classify

musicians' coping strategies using theoretical models, but rather to offer an overview of the coping strategies musicians use, and their relationship with MPA.

Over the past 35 years, numerous researchers have investigated the coping strategies musicians use to manage MPA. Studies range in methodology (both qualitative and quantitative), population (conservatoire and university students, amateur and professional, classical and jazz) and location, including: the UK (Steptoe and Fidler, 1987; Steptoe, 1989), North America (Wolfe, 1990; MacAfee and Comeau, 2022), Australia (Roland, 1994; Kenny et al., 2014), Italy (Biasutti and Concina, 2014), Spain (Hernández et al., 2018; Lupiáñez et al., 2022), Switzerland (Studer et al., 2011), Estonia (Kiik-Salupere and Ross, 2020), Turkey (Cornett and Urhan, 2021; Yadigaroğlu, 2021), Malaysia (Zakaria et al., 2013), Taiwan (Huang and Song, 2021) and Brazil (Burin et al., 2019). Across these studies, the strategies most commonly used to cope with MPA include positive self-talk, meditation, distraction and social support, relaxation exercises (muscle relaxation and deep breathing), increased practice, mock performance practice, ritualized behaviors and substances including beta blockers, alcohol and illicit drugs. Use of coping strategies varied between students and professionals, by gender, and by nationality (prayer was included in the Malaysian and Turkish studies, indicating the importance of cultural context).

There is a complex and seemingly paradoxical relationship between coping and MPA in that the two constructs are positively correlated – greater use of coping is associated with increased MPA (Steptoe, 2001). There are a number of possible explanations for this. Firstly, more anxious musicians are more likely to engage in deliberate coping behaviors which may prove effective, but MPA levels remain higher than their nonanxious colleagues (Steptoe and Fidler, 1987; Lehrer et al., 1990). Secondly, strategies deployed to alleviate MPA may be counterproductive (Langendörfer et al., 2006): Studies investigating specific coping strategies show positive correlations between substance use and MPA (Park, 2010) and dysfunctional coping (social support and avoidance strategies) and MPA (Biasutti and Concina, 2014). Thirdly, coping is a multidimensional construct with both adaptive and maladaptive components. Effective (adaptive) coping is associated with beneficial physiological states, reduced negative affect, perceiving anxiety as facilitative and adaptive MPA (Wolfe, 1990; Langendörfer et al., 2006; Papageorgi et al., 2007; Park, 2010). Conversely, inadequate (maladaptive) coping is significantly positively correlated with, and significantly predicts, MPA (Sinden, 1999; Langendörfer et al., 2006; van Fenema et al., 2013; Thomas and Nettelbeck, 2014). Lastly, coping is highly individual – the same strategies can be effective or ineffective depending on the individual, and indeed, strategies used by an individual may vary in efficacy across different performance contexts (Burin and Osório, 2017). For further discussion on the relationship between coping and MPA, see McNeil et al. (2022).

Researchers agree that effective coping is vital to managing MPA (Spahn et al., 2016; Osborne and McPherson, 2019). However, there remain gaps in current understanding of the relationship between coping and MPA: what mediates the efficacy of different coping strategies? Are some 'better' than others, or does their efficacy depend wholly on the individual? Are strategies more effective when combined? One interesting omission across these studies concerns what, exactly, musicians are trying to achieve through their coping efforts. If their aim is to eliminate MPA, this may be unrealistic, even undesirable, given the necessity of arousal for optimal performance, thus rendering the coping strategies ineffective. Arguably, being explicit about, and possibly reframing, what exactly the coping strategies are being used for may offer a different perspective on their efficacy.

Problematically, there remains little consensus regarding what actually constitutes effective coping. There are two main possible reasons for this ambiguity. Firstly, as discussed, coping is highly individual. Secondly, musical performance is largely researched through a pathological lens, focusing on musicians who experience debilitating MPA and therefore arguably cope inadequately. The few studies which have investigated the psychological characteristics of performers through a non-pathological lens found flexibility of coping and the deployment of a range of effective coping strategies (including positive anxiety appraisal and adaptive lifestyle habits) to be key (MacNamara et al., 2008; Pecen et al., 2018). Despite the significance of coping in predicting and sustaining, or protecting against, MPA, the complex interaction between the two constructs has not yet been studied sufficiently (Hernández et al., 2018).

Of particular concern is the prevalent use of substances to manage MPA (Kenny et al., 2014; Hernández et al., 2018; Burin et al., 2019). Alcohol impairs fine-motor skills, reaction time, memory and coordination, all vital for performance, and can lead to addiction and serious health issues (Zhukov, 2019). In Burin et al.'s (2019) study of 240 Brazilian musicians, 25% of participants who used alcohol to manage MPA showed signs of alcohol abuse. Beta-blockers can also have problematic side-effects and become psychologically addictive (Studer et al., 2011). Based on their study of Australian orchestral musicians, Kenny et al. (2014) reported that 30% of participants rely on beta-blockers to manage their anxiety. Indeed, the British Association of Performing Arts Medicine suggest beta blockers and tranquilizers as MPA management options on their website [British Association for Performing Arts Medicnie (BAPAM), n.d.], which suggests (1) that we are urgently in need of healthy and effective solutions to manage MPA and (2) the extent to which the music profession has normalized the use of medical substances to manage anxiety. To be clear, this is *not in any way* a moral crusade, but with so many musicians at both student and professional level, relying on substances to perform, it seems clear that musicians are experiencing real stress in large numbers and lack adequate coping strategies to manage it.

In sum, while musicians clearly utilize a range of coping strategies, these vary significantly in terms of healthfulness – ranging from healthy to destructive (Helding, 2016) – and efficacy, with significant numbers of musicians employing largely ineffective strategies (Kenny, 2005; Burin et al., 2019). Studies frequently report a disparity between the percentage of musicians using a particular strategy, and the percentage rating that strategy as being effective, indicating a lack of knowledge regarding which strategies actually help. Research suggests that in the absence of guidance regarding effective coping, musicians are likely to engage in coping mechanisms which may inadvertently exacerbate MPA (including seeking social support and avoidance) (Biasutti and Concina, 2014), whereas those who are taught effective coping strategies learn to manage the effects of MPA on performance (Juncos et al., 2017; Osborne and McPherson, 2019). Given its crucial role, it is concerning that so many musicians report limited coping skills. We turn now to available MPA interventions.

6.2. MPA interventions

In the 50 years since the first documented MPA intervention (Wardle, 1969), a plethora of interventions have emerged from a diverse range of theoretical perspectives. These include pharmacotherapy, psychodynamic and psychoanalytic therapies, cognitive, behavioral and cognitive-behavioral therapies, mindfulness-and-acceptance-based approaches, performance coaching, multimodal interventions, virtual reality and exposure therapies, among others. As a comprehensive review of available MPA interventions is beyond the scope of this review, Table 5 defines the major types of intervention, discusses their theoretical underpinnings and signposts the reader to empirical studies investigating their efficacy. There is a curious tension between individual intervention studies and prevalence rates: Studies broadly report statistically significant change at the *granular* level, yet this change is not seen at the *population* level. MPA's unchanged

TABLE 5 Definitions and theoretical underpinnings of MPA interventions with signposting to relevant empirical studies.

Intervention	Overview/Definition/Theoretical underpinnings
Pharmacotherapy	Physiological psychologists conceptualize MPA as a predominantly physiological phenomenon: the perception of threat activates the fight/flight response and the excessive adrenalin released causes physiological changes which can impair performance (Spahn, 2015). Based on this perspective, pharmacotherapy has been proposed as an effective solution to managing MPA (Nagel, 1990). Of the pharmacological treatments available, beta blockers are the most widely used, and widely investigated (Spahn, 2015). Beta blockers (beta-adrenergic blocking agents) are a group of medications designed to treat heart conditions by lowering blood pressure through blocking the impact of adrenalin. They are commonly used as a pharmacological treatment of MPA as they ameliorate some physiological symptoms, including tremor, reduced motor coordination, increased heart rate and palpitations (McGrath, 2012). Although in the early 1980s, several clinicians proposed beta-blockers as an effective solution to MPA (Neftel et al., 1982; James and Savage, 1983; Brandfonbrener, 1990), their use today is controversial, with ongoing debates regarding their efficacy and safety. Large-scale studies investigating the prevalence of beta-blocker use (Fishbein et al., 1988; Lockwood, 1989; Kenny et al., 2014) report 20–30% of professional orchestral musicians take beta-blockers to manage MPA. Anecdotal evidence suggests these figures may actually be significantly higher (Kenny, 2011; Patson and Loughlan, 2014). Concerningly, many of these users are unprescribed, and therefore without medical supervision. The use of beta-blockers remains controversial, with a lack of clarity regarding their efficacy, and more concerningly, their safety. Although they may be effective in reducing the physiological symptoms of MPA, they do not address the psychological components of MPA (Lehrer, 1987) and there are serious concerns associated with their use, especially without medical supervision (Kenny et al., 2014). Given the high levels of usage among professional musicians, and the lack of unanimous opinion regarding their safety (Lederman, 1999), there is an urgent need for approaches which tackle MPA effectively, thus reducing the risk to the health and wellbeing of musicians for whom unprescribed medication seems the only option. Current, methodologically rigorous, studies investigating beta-blockers are not possible due to ethical reasons. Furthermore, their use is associated with risks including psychological dependence, clinical side effects, compromised performance quality and increased anxiety (Brantigan et al., 1979; James and Savage, 1983; Lederman, 1999; McGinnis and Milling, 2005; Burin and Osório, 2017). The continued prevalence of beta blockers (based on both empirical and anecdotal evidence) indicates that there is no viable alternative.
Psychodynamic/psychoanalytic therapies	According to psychoanalytic theory, MPA stems from early life experiences (such as lack of secure attachment with significant caregivers) and expresses unconscious conflicts and defence mechanisms (Spahn, 2015). Based on this theoretical basis, psychoanalytic and psychodynamic therapists seek to enable performers to understand, and thus resolve, the conscious and unconscious conflicts associated with performing (Kenny, 2011). Proponents of this approach further argue that debilitating MPA may offer secondary gains, such as increased attention and care from significant others, or the avoidance of success which may pose greater psychological threat than failure (Sataloff et al., 1999). Only two case reports have investigated the use of psychoanalytic/psychodynamic therapy for MPA (Safirstein, 1962; Kenny et al., 2016). Although both studies reported significantly reduced MPA, they both employed a single-participant design, precluding generalizability. There is currently minimal empirical support for a psychodynamic approach (only two participants, five decades apart). Further research is needed to support the efficacy of this approach.
Cognitive therapies	Cognitive theories emphasize the impact of cognitions on physiological and behavioral symptoms, and argue that as humans have limited attentional resources, how attention is directed will impact task performance (Kenny, 2011; Spahn, 2015). Based on this theoretical premise, cognitive therapies seek to modify irrational or dysfunctional thought patterns through cognitive restructuring, a process of replacing negative, unhelpful, or catastrophic thinking with rational and constructive ways of thinking (Kenny, 2011). Several studies have linked MPA with dysfunctional cognitive processes, including catastrophizing and maladaptive perfectionism (Mor et al., 1995; McGinnis and Milling, 2005; Spahn, 2015), justifying the use of cognitive therapy to manage MPA. Although a number of studies have emphasized the role of negative cognitions in maintaining MPA (Steptoe and Fidler, 1987; Osborne and Franklin, 2002), very few studies have investigated the effects of cognitive therapies alone on MPA. (See Kendrick et al., 1982; Sweeney and Horan, 1982). Evidence to support cognitive therapies is equivocal – there is a lack of consistent evidence to support cognitive therapy as an independent modality (McGrath, 2012). Brugués (2019) posits that no conclusions can currently be drawn regarding the efficacy of cognitive interventions due to insufficient evidence resulting from a dearth of studies. A greater number of studies is needed to build a robust evidence base.

(Continued)

TABLE 5 (Continued)

Intervention	Overview/Definition/Theoretical underpinnings
Behavioral therapies	Behavioral interventions encompass those which seek to modify behaviors in order to modify one's state, including relaxation training and exposure therapies, and to alter dysfunctional behaviors which occur in response to anxiety (Brugués, 2019). Relaxation techniques focus on reducing the physiological symptoms of anxiety from one of two angles: 'mind to muscle' or 'muscle to mind' (Harris, 1986). 'Mind' strategies include visualization, while 'muscle' strategies include physical relaxation techniques such as stretching, or Progressive Muscular Relaxation (PMR) (McGrath, 2012). Exposure therapy, whether real or virtual, involves repeated, or graded, exposure to the feared stimulus in the absence of danger, so as to overcome anxiety (Wardle, 1969; Appel, 1976; Kendrick et al., 1982; Sweeney and Horan, 1982; Kim, 2008; McGrath, 2012; Bissonnette et al., 2015; Zyl, 2021; Osborne et al., 2022; Bellinger et al., 2023; Candia et al., 2023) While individually effective, the studies cannot be used in totality to form an evidence base as each study used entirely different treatment approaches: insight-relaxation, systematic desensitization, behavioral rehearsal, cue-controlled relaxation, breathing exercises, free improvisation, and virtual exposure therapy. Although individual studies report positive results, the heterogeneity of intervention modalities, assessment and outcome measures, and sampling strategies (too small/diverse) preclude firm conclusions regarding the efficacy of any one approach within behavioral interventions (Kenny, 2011; McGrath, 2012; Brugués, 2019). Behavioral interventions appear effective, but the heterogeneity of intervention modalities preclude firm conclusions regarding the efficacy of any one approach (Brugués, 2019).
Cognitive-behavioral therapy (CBT)	Emerging from the separate domains of cognitive therapy and behavioral therapy, CBT is based on the premise that emotions and behaviors are largely informed by cognitions – thoughts, ideas or beliefs about oneself and others; as well as impacting emotions and behaviors, cognitive processes which are irrational and self-defeating may cause, or intensify, physiological stress reactions (Kenny, 2011). CBT psychology largely attributes the sources of MPA to performers' recurrent cognitive patterns and attitudes (McGrath, 2012). CBT interventions are systematic, goal-oriented processes which teach participants to identify, evaluate and challenge (through modifying or replacing) maladaptive cognitive and behavioral patterns (Brugués, 2011a; McGrath, 2012; Spahn, 2015). At first glance, the evidence base for CBT as an effective intervention for MPA appears broad and compelling. Indeed, several studies report significant reductions in MPA following a CBT intervention (Clark and Agras, 1991; Osborne et al., 2007; Braden et al., 2015). However, the overall picture is more complex than it initially seems. In their systematic review of MPA interventions, Burin and de Lima Osório (2016) included six CBT studies. While Osborne et al. (2007) and Braden et al. (2015) both report significantly decreased MPA in adolescent music students, the other four studies are not CBT interventions. Bien Aime (2011) explicitly criticizes CBT and uses an approach called Solution-Focused Brief Therapy (SFBT), Errico (2012) uses a 'researcher-designed intervention' with no mention of CBT and both Clark and Williamon (2011) and Hoffman and Hanrahan (2012) investigate PST interventions, not CBT. Fernholz et al.'s (2019) systematic review tells a similar story. Of the 10 CBT studies reviewed, all indicated positive impact on MPA. However, six are not CBT interventions. Juncos and Markman (2016), Juncos et al. (2017) investigate Acceptance and Commitment Therapy (ACT), a method which they explicitly differentiate from CBT in terms of its theoretical underpinnings and treatment approach. Similarly, Lazarus and Abramovitz (2004) explicitly differentiate multimodal training (which they investigate in this study) from CBT. Bissonnette et al. (2015) investigate virtual reality exposure training, with no cognitive restructuring component. Nagel et al. (1989) combine cognitive therapy with relaxation and biofeedback training, with no attempt to isolate the specific impact of the CBT components. Rider (1987) describes his intervention as primarily music therapy, incorporating aspects of CBT alongside other treatment modalities. Of the remaining four studies, two use a single subject design (Norton et al., 1978; Salmon, 1992), precluding any generalizability. Sweeney and Horan (1982) ($n = 49$ undergraduate music students) compared CBT with cognitive and behavioral interventions, with only a fifth of participants in the CBT group, and concluded that it was no more effective than the single modalities. Brodsky and Sloboda (1997) ($n = 54$ orchestral musicians) assessed three treatment conditions: traditional psychotherapeutic counseling, counseling plus music, or counseling plus music and vibrotactile sensations. While treatment conditions were loosely based on a CBT approach, this study does not strictly adhere to a CBT treatment model. Cognitive-behavioral therapies are surprisingly difficult to evaluate as most of the CBT interventions included in reviews are in fact not CBT. Due to the limited number of studies on CBT as a single intervention and methodological weaknesses across studies, positive results require cautious interpretation, and conclusions cannot be drawn regarding its efficacy (Burin, and de lim A Osóri O, F., 2016). One major obstacle to ascertaining the efficacy of CBT is the lack of clarity between cognitive therapies, behavioral therapies and cognitive behavioral therapies. For example, Kendrick et al. (1982) is regularly cited as a key CBT study, yet the three treatment conditions are cognitive OR behavioral, or control group. Kenny (2011) argues that these distinctions are somewhat arbitrary because in humans, as sentient beings, behavior cannot occur without a cognitive component. Much greater conceptual clarity is needed to delineate clearly between these modalities. While CBT is regularly hailed as the gold standard in anxiety treatment, little evidence suggests it is superior to either cognitive or behavioral techniques in isolation (McGinnis and Milling, 2005). Minimal engagement with the mediators and moderators results in a lack of clarity on how the components of CBT effect change (McGinnis and Milling, 2005). A lack of longitudinal studies preclude conclusion regarding CBT's long-term benefits (Kenny, 2011) and further investigation is needed, with larger samples and adequate control groups (Nagel, 1990). Due to the limited number of studies on CBT as a single intervention and methodological weaknesses across studies, positive results require cautious interpretation, and conclusions cannot be drawn regarding its efficacy (Burin, and de lim A Osóri O, F., 2016). Conceptually, CBT may be problematic as it may increase performers' explicit-monitoring of cognitions which could interfere with the automatic processes and motor skills required for performance (Farnsworth-Grodd, 2012). See Faur et al. (2022) for a meta-analysis of CBT interventions for MPA.

(Continued)

TABLE 5 (Continued)

Intervention	Overview/Definition/Theoretical underpinnings
Performance coaching, psychological skills training and multimodal interventions	PST encompasses systematic practice of the psychological skills required for optimal performance, including self-regulation, motivation, imagery, goal setting, confidence, concentration and arousal management (Ford and Arvinen-Barrow, 2019). Based on the conceptualization of MPA as a complex, multi-multidimensional phenomenon, multimodal therapies combine various treatment modalities to target all aspects of MPA from an individualized person- and problem-oriented approach (Spahn, 2015). Modalities include psychodynamic therapy, CBT strategies, autogenic training, body awareness, mental techniques, imaginative techniques, breathing exercises, concentrative exercises, preparation techniques, performance training, cognitive strategies, video-feedback. Psychological/Mental Skills Training (PST/MST) has been used to enhance performance in athletes for over 50 years and has recently been investigated with musicians (see Lazarus and Abramovitz, 2004; Clark and Williamon, 2011; Osborne et al., 2014; Finch and Moscovitch, 2016; Hatfield, 2016; Spahn et al., 2016; Cohen and Bodner, 2019; Pecen, 2019; Finch and Oakman, 2022; Logan, 2022) Interestingly, in their systematic review of PST studies for musicians, Ford and Arvinen-Barrow (2019) include several interventions which are not labeled as PST anywhere else in relevant literature, including meditation, yoga and Alexander Technique. While several studies report a range of benefits, the authors criticized the disparate theoretical and empirical frameworks employed to underpin the interventions, as well as interventions' inconsistencies across length, frequency and dosage. Aside from the very small sample sizes which preclude generalizability, multimodal interventions are, by definition, highly complex, requiring interrogation into the impact of individual modalities (not included in any cited study). Furthermore, the complexity of a highly individualized (custom-made) approach precludes accessibility. Multimodal interventions and Psychological Skills Training appear highly effective, but their heterogeneity in terms of intervention design (components) preclude firm conclusions being drawn. Overall, PST interventions for musicians appear highly promising, but research is still in the early stages (Matei and Ginsborg, 2017) and there is a need for methodological homogeneity across studies to build a robust evidence base.
Meditation, mindfulness-and-acceptance-based approaches	Meditation can be defined as *"a self-regulatory practice designed to "train attention in order to bring mental processes under greater voluntary control"* (Walsh, 1995, p. 388) (in Kenny, 2005, p. 195). Mindfulness- and acceptance-based approaches posit that the resistance to challenging emotions creates more problems than the emotions themselves, and therefore promotes awareness and acceptance of difficult experiences (Osborne and Kirsner, 2022) (For studies investigating Acceptance and Commitment Therapy and meditation/mindfulness approaches, please see Chang et al., 2003; Lin et al., 2008; Juncos et al., 2017; Juncos and de Paiva e Pona, 2018, 2022; Stanson, 2019; Clarke et al., 2020; Czajkowski et al., 2020; Shaw et al., 2020; Mahony et al., 2022).
Alexander technique	Alexander Technique is a kinesthetic education method which improves posture and body use through verbal instruction and challenges habitual contraction through intentionally directed inhibition or action. The method emphasizes economy of effort and managing tension to develop optimal physical functioning (Valentine et al., 1995). Only one formal study has investigated the therapeutic impact of Alexander Technique on MPA. In their study with 15 music students, Valentine et al. (1995) reported pre- to post-treatment decrease in MPA and increased positive attitude toward performance, but no changes were statistically significant. In addition to a lack of statistically significant results, Valentine et al. (1995) employed an inadequate sample size and insufficient data to calculate effect sizes for three out of five outcome measures (Kenny, 2005; McGrath, 2012). Furthermore, except HRV, effects were only visible in low stress situations. Overall, more robust research is required to clarify whether weak evidence for beneficial effects can be confirmed (Brugués, 2019; Fernholz et al., 2019).
Yoga	Yoga is a holistic system of practices incorporating cognitive and physical techniques including physical postures (designed to develop strength and flexibility) and breathing exercises (Khalsa et al., 2009). Results (Khalsa et al., 2009; Stern et al., 2012) indicate significantly decreased MPA, and significantly reduced generalized anxiety and depression, with benefits maintained at follow-up. Despite positive findings, all studies reviewed used small sample sizes and problematically, did not acknowledge the complexity of the intervention in terms of its combination of mind and body practices. Burin and de Lima Osório (2016) suggest that anxiety reduction could be attributed to meditation techniques and breathing training, rather than the physical aspect of yoga training. Further research is required to clarify which aspects of yoga training mediate which benefits, and to build a more robust evidence base (Fernholz et al., 2019).
Music therapy	Music Therapy is the clinical, evidence-based use of music-based interventions to achieve individualized outcomes within a therapeutic relationship by a qualified and accredited professional (https://www.musictherapy.org/) [See Cheng (2020), Montello (1989) and Montello et al. (1990) for studies investigating music therapy and MPA]. While results appear promising, more studies are needed with larger sample sizes (Brugués, 2019).

(Continued)

prevalence indicates that current approaches are not having a meaningful impact overall. This section will review the current state of play of intervention research, from methodological and conceptual perspectives.

6.2.1. Methodological critique

From the studies cited in Table 5, one could reasonably infer that the state of play regarding MPA interventions is advanced, with a range of effective interventions to choose from. However, systematic

TABLE 5 (Continued)

Intervention	Overview/Definition/Theoretical underpinnings
Biofeedback	Developed in the 1960s by experimental psychologist Neal Miller, biofeedback training is based on the theoretical premise that awareness is a necessary first step to changing one's physiological state, and this awareness can enable new habits to be formed (Deen, 1999). Biofeedback training encompasses a range of techniques including heart rate variability (HRV) biofeedback, which involves slowing one's breathing rate to regulate autonomic activity, and electromyographic (EMG) biofeedback, which measures a range of bodily functions including blood pressure, heart rate, muscular tension and skin temperature. In either type, participants' physiological processes are fed back to them through sensors and real time on-screen monitoring, allowing them to gain control over these processes and thus alter their state. Additionally, biofeedback enables participants to identify the thoughts or emotions which trigger particular physiological responses (Niemann et al., 1993). In their study of 21 music students with severe MPA, Niemann et al. (1993) reported that biofeedback was effective in reducing MPA. However, the intervention's complexity (combined biofeedback with CB strategies, e.g., coping, muscle relaxation, breathing awareness & imagery) precludes drawing any firm conclusions regarding biofeedback as a single treatment modality. Van McKinney (1984) ($n = 32$ wind players) found no effect on anxiety levels but reported improved performance quality (effect size = 0.83). However, Kenny (2005) attributes this improvement to increased familiarity with the performance situation during the study, questioning the validity of the claim. Thurber et al. (2010) investigated the impact of HRV biofeedback training and emotional self-regulation techniques on MPA in 14 university music students. Results indicated significant reductions in MPA and heart rate variability as well as improved performance quality. However, as the intervention combined HRV with mental and emotional refocusing strategies, it is unclear which component mediated the improvements. In their study of 46 musicians, Wells et al. (2012) found that HRV biofeedback training produced no differential results but breathing regulation significantly increased HRV and reduced self-reported anxiety. Overall, studies investigating biofeedback report mixed results. While a few studies report positive results (Niemann et al., 1993; Thurber et al., 2010), Van McKinney (1984) and Wells et al. (2012) found no reduction in MPA. Unfortunately, the studies all combine biofeedback with other treatment modalities, precluding any conclusions being drawn regarding its efficacy. McGinnis and Milling (2005) argue that although some biofeedback studies report positive change (Nagel et al., 1989; Niemann et al., 1993), it is impossible to differentiate the effects of biofeedback training from other components of the interventions. It may offer a beneficial option in conjunction with other modalities, but further research is required. Regarding biofeedback training alone, there is no good evidence to suggest it reduces MPA (Brugués, 2019). Studies investigating biofeedback training in isolation are needed to support its efficacy.
Hypnotherapy	The term 'hypnosis' refers to *"a state of physical relaxation accompanied and induced by mental concentration"*; in the context of interventions, the American Psychological Association defines hypnotherapy as a procedure used to "*encourage and evaluate responses to suggestions for changes in subjective experience, alterations in perception, sensation, emotion, thought, or behaviour*" (McGrath, 2012, p. 11). According to large-scale cross-sectional studies, hypnosis was rated as beneficial in managing MPA by 60–76% of musicians (Fishbein et al., 1988; D. Kenny et al., 2014; Middlestadt, 1990). However, very few studies have investigated empirically the impact of hypnosis on MPA (see Plott, 1986; Stanton, 1993). More recently, cognitive hypnotherapy has been combined with EMDR by Brooker (2018), showing promising results. Overall, there are insufficient data available to draw any conclusions regarding the efficacy of hypnosis for MPA (Brugués, 2019).
Other modalities	• Oxytocin (Sabino et al., 2020) • Expressive writing (Tang and Ryan, 2020) • Depth relaxation music therapy and silence (Pfeifer et al., 2020)

reviews and meta-analyses tell a somewhat different story, reporting some positive evidence but arguing that evidence is largely weakened by methodological limitations. Although numerous MPA interventions have been developed and evaluated, it has not yet been possible to build a robust evidence base for any single intervention due to a range of methodological weaknesses within studies, methodological heterogeneity across studies and a lack of replication (McGinnis and Milling, 2005; Goren, 2014; Matei and Ginsborg, 2017; Fernholz et al., 2019; Zhukov, 2019).

One key methodological limitation is the lack of consistency in MPA definitions across studies and a lack of clarity regarding the theoretical and conceptual issues underpinning MPA within studies (Kenny, 2005). The terms MPA, performance anxiety, and stage fright continue to be used interchangeably across intervention studies, often without clarifying their exact meanings (Fernholz et al., 2019). The lack of a clear and consistent definition makes it difficult to know exactly what changes are occurring both within, and across, studies. Conceptual issues regarding MPA definitions will be discussed below. The lack of clarity regarding what constitutes MPA and the heterogeneity of MPA definitions used is, of course, reflected in the disparate outcome measures used, including some non-validated instruments (Kenny, 2005; Burin and de Lima Osório, 2016). In their systematic review, Fernholz et al. (2019) concluded it was often unclear exactly what was being measured, precluding clear interpretation of results within studies and comparison across studies and recommend using validated and standardized measurement tools.

As problematic as what is being measured, is what is not measured. A good evaluation is a crucial precursor to any intervention (Nagel, 2010), yet intervention studies often omit pre-test scores (Kenny, 2005; McGinnis and Milling, 2005; Zhukov, 2019). There is

also a lack of process evaluations including adherence and acceptability, and of interrogation into specific components of interventions in terms of mediating and moderating variables (McGinnis and Milling, 2005), which is especially problematic in complex or combined interventions. A lack of follow-up data (longitudinal studies) makes it impossible to know long-term efficacy (Kenny, 2005; McGinnis and Milling, 2005).

Most studies use very small sample sizes, meaning that the statistical power is insufficient to justify definitive conclusions regarding interventions' efficacy (Kenny, 2011; Goren, 2014; Zhukov, 2019). Overall, studies with larger and more homogenous subjects are needed (Brugués, 2011b). Studies often do not use a control group (Kenny, 2005; Matei and Ginsborg, 2017; Zhukov, 2019). This is especially problematic when studies use performance tasks to assess MPA, as differential results could be attributed to time spent practising, task familiarity or repeated exposure to the task. Few studies explicate the diagnostic inclusion/exclusion criteria used, or the level of MPA experienced by participants: heterogeneity in participants' levels of MPA may obscure significant treatment effects (Kenny, 2011; Fernholz et al., 2019). In their systematic review, Burin and de Lima Osório (2016) reported that the majority of studies reviewed included no information regarding participants' levels of MPA, whether normal or 'pathological' and argue that this information is crucial to draw conclusions regarding interventions' efficacy in managing MPA. While it seems self-evident, McGinnis and Milling (2005) argue that research evaluating the efficacy of interventions designed to ameliorate MPA must be conducted with performers who actually experience MPA, and that findings based on participants with subclinical MPA levels cannot be used to support conclusions regarding interventions' efficacy for MPA. Lastly, one reason it has not yet been possible to build a robust evidence base for any one intervention is the lack of standardized techniques utilized across different interventions within categories. The heterogeneity of treatment modalities, intervention duration and dosage (intensity) preclude comparison across studies of similar interventions (Kenny, 2005; Burin and de Lima Osório, 2016). Within individual studies, limitations include the absence of a manual detailing treatment protocol and the use of multiple therapists, or interventions being delivered by the principal investigator, risking researcher bias (McGinnis and Milling, 2005).

Based on their systematic reviews, Kenny (2005) and McGinnis and Milling (2005) concluded that there is an urgent need for more methodologically robust studies investigating MPA interventions, and highlighted key methodological weaknesses including conceptual ambiguities, inadequate assessment measures and small and heterogenous samples. Fifteen years later, the state of play remains much the same with recent systematic reviews recommending cautious interpretation of positive results based on a body of knowledge which remains inconclusive, inconsistent, and methodologically weak (Burin and de Lima Osório, 2016; Fernholz et al., 2019; Zhukov, 2019). In sum, key methodological limitations across intervention studies include disparate definitions and outcome measures, missing data, small and heterogenous samples, lack of control group, unclear inclusion/exclusion criteria and heterogenous intervention components within categories and lack of engagement with mechanisms of change.

If these methodological limitations of individual studies reporting positive change were the only issue, then replication would be the obvious next step. However, while these methodological limitations certainly weaken the evidence base for any one intervention, they do not explain why effects being reported at the study level are not seen at the population level. Poor-quality evidence does not mean interventions are not working, which poses an important question left unanswered by systematic reviews and meta-analyses: Why are interventions not having a meaningful impact on MPA? While there is no single answer, there are several possibilities worth exploring, including accessibility issues, MPA conceptualizations, and excessive focus on symptoms.

6.2.2. Conceptual critique

Based on individual studies, it is entirely plausible that effective interventions *do* exist, but that their impact is limited due to *accessibility barriers* including prohibitive cost or ineffective dissemination. For example, Spahn et al.'s (2016) multimodal intervention seems highly effective, but its individually tailored design precludes widespread availability, and it has not yet entered the mainstream of interventions – it is unclear where or how one would access it. Overall, empirically-validated cost-effective and accessible interventions are lacking.

In addition to logistical accessibility issues, musicians may not seek help due to the *stigma* (both real and perceived) still associated with MPA (McGrath, 2012; van Fenema et al., 2013). While there is now seemingly greater openness around physical injuries (Horvath, 2001; Brandfonbrener, 2004), research suggests that this openness has not yet reached psychological issues, with musicians reportedly associating MPA with personal weakness and/or shame (Juncos et al., 2017). As stigma (associated with feelings of shame, disgrace or secrecy) plays a significant role in determining health-seeking behaviors outside of music (Eisenberg et al., 2009; Bharadwaj et al., 2017), this could logically apply to musicians as well.

As discussed in Section 3.2.1, MPA is predominantly conceptualized pathologically, which implies that it is an affliction to be prevented, avoided or eliminated to perform well and happily (Senyshyn and O'Neill, 2001). Based on this *conceptualization*, interventions largely seek to manage MPA through ameliorating symptoms. Although logical, this approach is problematic in a number of ways. Firstly, there is an implicit assumption that fewer or no 'symptoms' is the desired outcome, yet research consistently indicates that some anxiety (or arousal) is intrinsic, even beneficial, for performance (Kenny, 2005; Matei and Ginsborg, 2017) and that reducing anxiety may not be a useful, or even optimal, goal (Kirchner, 2003; Nagel, 2010; Lawrence, 2019). Indeed, relaxation is both unrealistic and counterproductive for peak performance in high-pressure contexts (Pecen et al., 2016), as illustrated by these quotes:

> *"Relax at the Tchaikovsky competition? Relax when you've blown $900 to fly across the country for your two-minute audition for the only symphony flute job to come open this year? Relax when your symphony job security depends on near-perfect technique in each and every concert until you're tenured? I don't think so"* (Greene, 2012, p. 1).

> *"Trying to calm down before a stressful performance may not only be futile – but counterproductive to boot!"* (Kageyama, 2022).

Secondly, research suggests that 'symptoms' themselves may in fact not be the issue. In their evaluation of a mental skills training program for conservatoire students, Clark and Williamon (2011) found no significant differences in state or trait anxiety post intervention, yet participants reported more facilitative views toward MPA, indicating altering one's interpretation may alleviate MPA's impact more effectively than reducing it. While MPA research has largely focused on whether performers interpret MPA as either positive or negative, research outside of the musical domain suggests that anxiety-related psychopathology is characterized by experiential *avoidance* of fear, not the *experiencing* of it. In this framework of understanding anxiety, the reaction *to*, not the presence *of,* anxiety is where problems arise, which has important implications for how we define MPA – perhaps not as the anxiety itself, but in the reaction to the anxiety?

Thirdly, focusing on the *presence* of 'symptoms' does not address the underlying mechanisms by which MPA can disturb performance, as discussed in Section 5.3. Focusing on these mechanisms (e.g., interaction, interpretation and attention regulation) may be more effective.

Fourthly, excessive focus on symptoms overlooks the constellation of other factors associated with MPA, including personality traits and occupational stress, as discussed in Section 4. Indeed, several interventions focus only on one domain (cognitions or behaviors), thus not sufficiently addressing MPA's multidimensionality (Brandfonbrener, 1999). Interventions which neglect underlying psychological factors are unlikely to succeed (Pecen et al., 2016). Conceptualizing MPA as a multidimensional construct involving complex interaction between the individual and their environment suggests a more holistic approach to its management: MPA interventions should ideally address the full range of MPA processes alongside the numerous vulnerability factors associated with it (Osborne and Franklin, 2002).

Lastly, efforts to reduce MPA largely rely on intentionally changing one's state (e.g., from anxious to relaxed). There is growing awareness that efforts to reduce unwanted experience creates resistance, inadvertently exacerbating anxiety, as illustrated by this quote:

> *"Any attempt to not feel the fear splits the performer psychically into two persons, the feeler and the repressor. It is the splitting, not the fear, that limits capability…it is the attempt not to feel rather than the feeling that impairs the performance"* (Conable and Conable, 1995, p. 115).

Despite the wide range of interventions on offer, there remains no established way of dealing with MPA. Section 7 will briefly summarize the current state of play, before suggesting a reconceptualization of MPA.

7. Discussion: summary and reconceptualization

MPA affects numerous musicians across all ages, nationalities and musical genres. It occurs in response to threat and manifests in physiological, cognitive, emotional and behavioral 'symptoms' which can negatively affect performer and/or performance. It co-varies with a wide range of maladaptive personality traits as well as situational stressors associated with the performance context and is clustered diagnostically within the anxiety disorders landscape. MPA is widely considered to be a significant occupational hazard, and musicians use a range of coping strategies to manage it, many of which are ineffective and/or unhealthy. Despite the existence of numerous interventions, unchanged prevalence figures indicate these are not having a meaningful impact. After decades of research, we still do not really know how best to offer appropriate support to musicians experiencing MPA. We suggest that prevailing views on MPA are conceptually flawed and crucially, not serving musicians.

Zooming out briefly, the broader conversation around mental health has seen a shift over the last 40 years, from the biomedical model traditionally used in psychiatry, to the biopsychosocial model (Engel, 1977). This model emphasizes the importance of psychological and social factors alongside biological factors in understanding illness (Alonso, 2004). Although still awaiting empirical support, Manchester (2011) and Mumm et al. (2020) have convincingly proposed applying the biopsychosocial model to understanding MPA's etiology. While the biopsychosocial model offers a useful heuristic to understand the many factors associated with MPA's development, we suggest moving away from both the biomedical and biopsychosocial models, as both are used to describe illness. We propose removing any medical connotation from MPA and reconceptualizing it as an adaptive response to a unique constellation of demands and stressors, which will now be discussed.

7.1. The soil MPA grows in

As discussed in Section 4.2, MPA is associated with/predicted by a number of *intrinsic factors* including trait anxiety, neuroticism, low self-esteem, maladaptive dimensions of perfectionism, guilt- and shame-proneness, and maladaptive cognitive style characterized by rumination, fear of negative evaluation and judgmental attitude. Across relevant literature, these traits are (implicitly) viewed as individual deficiencies, with minimal discussion of the soil they grow in.

Research clearly shows the challenges facing musicians on the path to a professional career, including fear experienced due to excessive demands from parents or teachers (Mumm et al., 2020), managing the consequences of early specialization, grueling practice schedules, social isolation, psychological pressure (Pecen et al., 2016), neuromuscular and musculoskeletal overuse and irregular sleep and work schedules (Pecen et al., 2018). In her book 'Music from the Inside Out', Tomlinson (2018) writes

> *"In our culture, judgement underpins everything. Learning to play an instrument to professional standards is unbelievably demanding. You need skill, commitment and discipline; you need to master your instrument, faithfully interpret the music you are playing, manage your nerves and above all, be free enough to express yourself. And if you are doing this in a culture that has judgement at its core, there are consequences: judgement is dangerous"* (p. 3).

If we look at MPA as a societal rather than an individual phenomenon, many, if not all, of the traits associated with MPA start

to seem less like coincidental, intrinsic deficiencies, and more like natural, even predictable, adaptations to years of intensive musical training in competitive and often un-nurturing environments that have judgment at their core, as Tomlinson suggests. Arguably, to be a classical musician and NOT a perfectionist, or neurotic, or fear negative evaluation, would be a radical act of exceptionalism given the educational and professional cultures within which musicians often spend their formative years. We turn now to the *extrinsic factors* associated with MPA's etiology.

7.2. Performance demands

Research unequivocally highlights the demands of musical performance, including the relentless pressure to perform to near-perfect levels (McNeil et al., 2022), executing complex motor, cognitive, psychological and emotional skills/processes under close scrutiny and in highly anxiogenic situations (Hays, 2009; Antonini Philippe et al., 2019; de Figueiredo Rocha, 2020). The success and longevity of a musical career depends on musicians' ability to delivery consistently high-quality performances under pressure (Kenny, 2011; Williamon et al., 2013). While musicians are often compared to athletes in terms of the psychophysical demands of elite performance, musicians receive none of the specialist training or support routinely offered to athletes, including physiotherapy, nutrition, and psychological skills training.

Compounding the pressures of performance are the realities of working within an insecure and highly competitive profession – well-documented occupational challenges include long and anti-social working hours, adverse working conditions, the challenges of touring and financial unpredictability (Voltmer et al., 2012; van Fenema et al., 2013; Sousa et al., 2016). Based on their 2016 study investigating musicians' mental health, Gross & Musgrave write *"Music making is therapeutic but making a career out of music is destructive…whereas artists find solace in the production of music, the working conditions of forging a musical career are traumatic."* (2016, p. 12).

Unsurprisingly, sustaining the demands of high-level performance against the backdrop of a challenging profession often generates stress and anxiety for performers (Antonini Philippe et al., 2022). Indeed, research suggests that managing this anxiety is a *"constant battle even for the most accomplished musicians and performers"* (Tang and Ryan, 2020, p. 1). Seemingly, MPA poses a challenge that many, if not all, performers must meet (McGinnis and Milling, 2005; Spahn et al., 2010), suggesting that it is just part of the fabric of life as a performing musician. As Hays (2009) asks, "*when a condition is ubiquitous, is it diagnosable?*" (p. 105), succinctly problematizing diagnosing a 'normative aspect of performance'.

7.3. Conclusion

In 2020, biological anthropologists Syme and Hagen (2020) published a ground-breaking paper in which they suggest reclassifying 'diseases of the mind' in an entirely new framework consisting of: (1) highly heritable (rare) disorders including schizophrenia and OCD, (2) disorders associated with age-related deterioration such as Alzheimer's disease, (3) a mismatch between ideal and modern environments including ADHD and (4) functional responses to adversity, including PTSD and anxiety disorders. We propose a similarly radical paradigm shift – removing any medical connotation from MPA and reconceptualizing it as a *functional response to adversity*, where adversity represents the intersection between managing the demands of high-pressure performing situations, a competitive and insecure professional environment, and personality traits associated with elite musical training. Acknowledging this wider context seems key in understanding how MPA develops and sustains, not as an individual deficiency, but as a functional response to a highly challenging education and performance environment.

The World Health Organization (WHO, 2004) defines anxiety as a "normal and healthy reaction to perceived danger that triggers a variety of physical, mental, and behavioral changes in order to facilitate a speedy response" (cited in Osborne and Kirsner, 2022, p. 206). While performing a Mozart concerto may not be the same as encountering a hungry tiger, we suggest there are many rational reasons why performers might, on some level, perceive performing as threatening. The vulnerability and exposure inherent in performance, as well as the reliance on the positive opinion of others (colleagues, critics, agents, fixers, concert promoters or audiences) to pay one's rent, arguably pose a very real and practical threat, making anxiety a rational response. The recent headline news regarding Arts Council England and the BBC funding cuts offer a flavor of the fragility of the musical ecosystem and the very real threat this poses to musicians' livelihoods and wellbeing.

Anxiety is a biologically adaptive response, which has ensured human survival for millennia. Although MPA is almost universally described using medical language ('*symptoms*', '*disorder*', '*treatment*' etc.), we suggest that the body's ability to react to what it perceives as threatening is not a sign of illness, but rather signifies a functioning autonomic nervous system. As an analogy: smoke alarms exist to detect and alert us to fire. If our smoke alarm activates in response to burnt toast, we would not disable it, but rather understand that an overly-cautious alarm is preferable to the opposite. We might open a window or wave a tea towel at the agitated alarm, to reassure it that there is no fire. Imagine if we could similarly learn to reassure our nervous system – to understand that it is doing exactly what it evolved to do, and to thank it for its tireless service, to see it as a protector, not a disease.

We question the use of medicalized language and propose using more neutral terms 'response', 'manifestation', or 'experience'. This may seem like semantics, but consider the felt impact on a performer when discussing their 'symptoms' – it immediately conjures up images of infection or disease – MPA is arguably neither, and we suggest that using the same language to describe it is deeply problematic. Additionally, diagnostic labeling has '*pejorative implications for normative behaviour*' (Hays, 2009) and arguably perpetuates the stigma, shame and silence still surrounding MPA (Patson and Loughlan, 2014). Re-imagining 'symptoms' as 'the body seeking to protect itself from threat, as organisms evolved to do' could open up new ways of thinking about how we meet challenging experiences. In sum, MPA is not a virus! Reconceptualizing MPA as a normal and adaptive response to the well-documented stressors associated with performance and a competitive and insecure profession, could profoundly change the conversation around how performers can be supported throughout their musical lives.

8. Potential developments: implications for theory and practice

Our proposed reconceptualization of MPA, from disorder to adaptive response, has implications for both theory and practice, which will now be discussed.

8.1. Implications for theory

Based on this review, we suggest the following as areas for potential future research:

- Terminological clarity: Using the same term ('MPA') to describe a phenomenon which can be positive, mildly challenging, a psychological disorder or a completely normal part of a performer's life seems at best, unhelpful, at worst deeply problematic. We suggest that developing a coherent MPA theory requires greater terminological clarity.
- Conceptual clarity: A new MPA definition which moves away from the medical model and encompasses the complexity and individuality with which MPA manifests, while acknowledging the adaptive role MPA plays in terms of preparing the body to deal with perceived threat.
- A new standardized assessment tool is required to reflect a broader conceptualization of MPA, and to enable comparability across intervention studies from different theoretical perspectives.
- As research has largely focused on debilitating MPA, those who experience MPA positively and/or manage it successfully are underrepresented in scientific literature, highlighting an important gap in current understanding.
- Impact of MPA on performer and performance: the factors which mediate the intensity and interpretation of MPA (and thus its impact on performer and/or performance) are currently scattered across the literature. Further research is needed to amalgamate these factors into one coherent theory which accounts for MPA's impact on performance and/or performer.
- MPA Etiology – Longitudinal research investigating the development of traits which predict or protect against MPA within musical training environments such as specialist music schools and conservatoires, as well as qualitative research to better understand the relationship between MPA and its comorbidities.

8.2. Implications for practice: the role of music education

Given the importance of coping with MPA in establishing and maintaining a successful performing career, you might think that it would be core business for music schools and conservatoires. Indeed, a few institutions have integrated empirically evaluated interventions into their curricula – see Candia et al. (2023) and Spahn et al. (2016) for notable examples. However, this is far from standard practice – research shows that teaching effective coping is not yet embedded in musical training (Pecen et al., 2016; Araújo et al., 2017) [As a comprehensive review of the field of music education is beyond the scope of this paper, please see the following sources for further discussion: Hildebrandt (2009), Hildebrandt and Nübling (2004), and Mazzarolo et al. (2023)].

We suggest that music education plays a critical role in the formation of perceptions and beliefs around performance, and is therefore a formative place for the development of a problematic or constructive approach to MPA. Where else than in music education – from the earliest music lessons to the training of professionals and future teachers – can a reconceptualization of MPA and the integration of effective coping strategies succeed? We suggest that musical training should, as standard practice, (1) include psychoeducation regarding the physical and psychological demands of performance (including understanding the body's inbuilt stress response), and (2) the training of effective and empirically-validated practice and performance strategies to manage these demands [see Hildebrandt (2009) for an example of a learnable 'stage disposition' which includes the training of performance-appropriate distribution of muscle tension and attentional focus for peak performance]. Equipping students with a solid understanding of MPA as well as the skills to manage it seems vital in preparing the next generation of musicians to perform healthily and happily.

Author contributions

RH conducted the literature search for this review and wrote the first draft of the manuscript. RH and TC developed the ideas for both content and structure. Both authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Alonso, Y. (2004). The biopsychosocial model in medical research: the evolution of the health concept over the last two decades. *Patient Educ. Couns.* 53, 239–244. doi: 10.1016/S0738-3991(03)00146-0

Altenmüller, E., and Ioannou, C. I. (2016). "Chapter 7 – music performance: expectations, failures, and prevention" in *Performance psychology*. eds. M. Raab, B. Lobinger, S. Hoffmann, A. Pizzera and S. Laborde (Cambridge, MA: Academic Press), 103–119.

Antonini Philippe, R., Cruder, C., Biasutti, M., and Crettaz von Roten, F. (2022). The Kenny music performance anxiety inventory-revised (K-MPAI-R): validation of the Italian version. *Psychol. Music* 51, 565–578. doi: 10.1177/03057356221101430

Antonini Philippe, R. A., Kosirnik, C., Ortuñu, E., and Biasutti, M. (2019). Between flow and anxiety: A study of the factors affecting musicians' performances. Available at: https://serval.unil.ch/resource/serval:BIB_850B8A3468F7.P001/REF.pdf

Appel, S. S. (1976). Modifying solo performance anxiety in adult pianists. *J. Music. Ther.* 13, 2–16. doi: 10.1093/jmt/13.1.2

Araújo, L. S., Wasley, D., Perkins, R., Atkins, L., Redding, E., Ginsborg, J., et al. (2017). Fit to perform: an investigation of higher education music students' perceptions, attitudes, and Behaviors toward health. *Front. Psychol.* 8:1558. doi: 10.3389/fpsyg.2017.01558

Aubry, L., and Küssner, M. B. (2023). Music performance anxiety and its relation to parenting style and sensory processing sensitivity. *Jahrbuch Musikpsychologie* 31:e155. doi: 10.5964/jbdgm.155

Baer, R. A. (2003). Mindfulness training as a clinical intervention: a conceptual and empirical review. *Clin. Psychol. Sci. Pract.* 10, 125–143. doi: 10.1093/clipsy.bpg015

Baltzell, A. L. (2016). "Self-compassion, distress tolerance, and mindfulness in performance" in *Mindfulness and performance*. ed. A. L. Baltzell (Cambridge: Cambridge University Press), 53–77.

Bandura, A. (1991). "Self-efficacy conception of anxiety" in *Anxiety and self-focused attention*. eds. R. Schwarzer and R. A. Wicklund (Reading: Harwood Academic Publishers), 89–110.

Barbar, A. E. M., de Souza Crippa, J. A., and de Lima Osório, F. (2014). Performance anxiety in Brazilian musicians: prevalence and association with psychopathology indicators. *J. Affect. Disord.* 152, 381–386. doi: 10.1016/j.jad.2013.09.041

Barlow, D. H. (2000). Unraveling the mysteries of anxiety and its disorders from the perspective of emotion theory. *Am. Psychol.* 55, 1247–1263. doi: 10.1037/0003-066X.55.11.1247

Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic. 2nd Edn*. New York: Guilford Press.

Barros, S., Marinho, H., Borges, N., and Pereira, A. (2022). Characteristics of music performance anxiety among undergraduate music students: a systematic review. *Psychol. Music* 50, 2021–2043. doi: 10.1177/03057356211066967

Bartel, L. R., and Thompson, E. G. (1994). Coping with performance stress: A study of professional orchestral musicians in Canada. *Q. J. Music Teach. Learn.* 5, 70–78.

Beck, A. T., and Clark, D. A. (1988). Anxiety and depression: an information processing perspective. *Anxiety Res.* 1, 23–36. doi: 10.1080/10615808808248218

Bellinger, D., Wehrmann, K., Rohde, A., Schuppert, M., Störk, S., Flohr-Jost, M., et al. (2023). The application of virtual reality exposure versus relaxation training in music performance anxiety: A randomized controlled study. *Review*. doi: 10.21203/rs.3.rs-2967418/v1

Benson, H., and Klipper, M. (2009). *The relaxation response*. New York, NY: Harper Collins.

Bharadwaj, P., Pai, M. M., and Suziedelyte, A. (2017). Mental health stigma. *Econ. Lett.* 159, 57–60. doi: 10.1016/j.econlet.2017.06.028

Biasutti, M., and Concina, E. (2014). The role of coping strategy and experience in predicting music performance anxiety. *Music. Sci.* 18, 189–202. doi: 10.1177/1029864914523282

Bien Aime, J. K. (2011). *Managing performance anxiety in music students: Using a solution focused approach [Doctoral Dissertation]*. Fort Lauderdale, FL: Nova Southeastern University.

Bissonnette, J., Dubé, F., Provencher, M. D., and Moreno Sala, M. T. (2015). Virtual reality exposure training for musicians: its effect on performance anxiety and quality. *Med. Probl. Perform. Art.* 30, 169–177. doi: 10.21091/mppa.2015.3032

Bögels, S. M., Alden, L., Beidel, D. C., Clark, L. A., Pine, D. S., Stein, M. B., et al. (2010). Social anxiety disorder: questions and answers for the DSM-V. *Depress. Anxiety* 27, 168–189. doi: 10.1002/da.20670

Braden, A. M., Osborne, M. S., and Wilson, S. J. (2015). Psychological intervention reduces self-reported performance anxiety in high school music students. *Front. Psychol.* 6:195. doi: 10.3389/fpsyg.2015.00195

Brand, M. (2004). Collectivistic versus individualistic cultures: A comparison of American, Australian and Chinese music education students' self-esteem. *Music. Educ. Res.* 6, 57–66. doi: 10.1080/1461380032000182830

Brandfonbrener, A. G. (1986). An overview of the medical problems of musicians. *J. Am. Coll. Heal.* 34, 165–169. doi: 10.1080/07448481.1986.9939631

Brandfonbrener, A. G. (1990). Beta blockers in the treatment of performance anxiety. *Med. Probl. Perform. Art.* 5, 23–26.

Brandfonbrener, A. G. (1999). Performance anxiety." different strokes for different folks". *Med. Probl. Perform. Art.* 14, 101–102.

Brandfonbrener, A. G. (2004). Healthier music students: can medicine and music prescribe in concert. *Med. Probl. Perform. Art.* 19, 1–2. doi: 10.21091/mppa.2004.1001

Brantigan, C. O., Brantigan, T. A., and Joseph, N. (1979). The effect of beta blockade on stage fright. A controlled study. *Rocky Mt. Med. J.* 76, 227–233.

British Association for Performing Arts Medicnie (BAPAM). (n.d.) Managing performance anxiety. BAPAM. Available at: https://www.bapam.org.uk/managing-performance-anxiety/

Brodsky, W. (1996). music performance anxiety reconceptualized: A critique of current research practices and findings. *Med. Probl. Perform. Art.* 11, 88–98.

Brodsky, W., and Sloboda, J. A. (1997). Clinical trial of a music generated vibrotactile therapeutic environment for musicians: Main effects and outcome differences between therapy subgroups. *J. Music. Ther.* 34, 2–32. doi: 10.1093/jmt/34.1.2

Brooker, E. (2018). Music performance anxiety: A clinical outcome study into the effects of cognitive hypnotherapy and eye movement desensitisation and reprocessing in advanced pianists. *Psychol. Music* 46, 107–124. doi: 10.1177/0305735617703473

Brugués, A. O. (2011a). Music performance anxiety—part 1. A review of its epidemiology. *Med. Probl. Perform. Art.* 26, 102–105. doi: 10.21091/mppa.2011.2015

Brugués, A. O. (2011b). Music performance anxiety—part 2: A review of treatment options. *Med. Probl. Perform. Art.* 26, 164–171. doi: 10.21091/mppa.2011.3026

Brugués, A. O. (2019). *Music performance anxiety: A comprehensive update of the literature*. Newcastle upon Tyne: Cambridge Scholars Publishing.

Burin, A. B., Barbar, A. E. M., Nirenberg, I. S., Osório, F. D. L., Burin, A. B., Barbar, A. E. M., et al. (2019). Music performance anxiety: perceived causes, coping strategies and clinical profiles of Brazilian musicians. *Trends Psychiatry Psychother.* 41, 348–357. doi: 10.1590/2237-6089-2018-0104

Burin, A. B., and de Lima Osório, F. (2016). Interventions for music performance anxiety: results from a systematic. *Arch. Clin. Psychiatry* 43, 116–131. doi: 10.1590/0101-60830000000097

Burin, A. B., and Osório, F. L. (2017). Music performance anxiety: A critical review of etiological aspects, perceived causes, coping strategies and treatment. *Arch. Clin. Psychiatry* 44, 127–133. doi: 10.1590/0101-60830000000136

Butković, A., Vukojević, N., and Carević, S. (2022). Music performance anxiety and perfectionism in Croatian musicians. *Psychol. Music* 50, 100–110. doi: 10.1177/0305735620978692

Candia, V., Kusserow, M., Margulies, O., and Hildebrandt, H. (2023). Repeated stage exposure reduces music performance anxiety. *Front. Psychol.* 14:1146405. doi: 10.3389/fpsyg.2023.1146405

Cannon, W. B. (1927). The James-Lange theory of emotions: A critical examination and an alternative theory. *Am. J. Psychol.* 39, 106–124. doi: 10.2307/1415404

Causer, J., Holmes, P. S., Smith, N. C., and Williams, A. M. (2011). Anxiety, movement kinematics, and visual attention in elite-level performers. *Emotion* 11, 595–602. doi: 10.1037/a0023225

Chan, M.-Y. (2011). *The relationship between music performance anxiety, age, self-esteem, and performance outcomes in Hong Kong music students [PhD thesis]*. Durham: Durham University.

Chang, J. C., Midlarsky, E., and Lin, P. (2003). Effects of meditation on music performance anxiety. *Med. Probl. Perform. Art.* 18, 126–130. doi: 10.21091/mppa.2003.3022

Chang-Arana, Á. M., Kenny, D. T., and Burga-León, A. A. (2018). Validation of the Kenny Music Performance Anxiety inventory (K-MPAI): A cross-cultural confirmation of its factorial structure. *Psychol. Music* 46, 551–567. doi: 10.1177/0305735617717618

Chattin, L. B. (2019). *The big five personality types and music performance anxiety in collegiate piano students. [PhD Thesis]*. Columbia, SC: University of South Carolina.

Cheng, Y. (2020). Psychological intervention of music therapy on performance anxiety of vocal music students. *Revista Argentina de Clínica Psicológica* 29:1333. doi: 10.24205/03276716.2020.375

Chow, K., and Mercado, E. (2020). Performance anxiety and the plasticity of emotional responses. *Cognit. Emot.* 34, 1309–1325. doi: 10.1080/02699931.2020.1749568

Clark, D. B. (1989). Performance-related medical and psychological disorders in instrumental musicians. *Ann. Behav. Med.* 11, 28–34. doi: 10.1207/s15324796abm1101_4

Clark, D. B., and Agras, W. S. (1991). The assessment and treatment of performance anxiety in musicians. *Am. J. Psychiatry* 148, 598–605. doi: 10.1176/ajp.148.5.598

Clark, T., Lisboa, T., and Williamon, A. (2014). An investigation into musicians' thoughts and perceptions during performance. *Res. Stud. Music Educ.* 36, 19–37. doi: 10.1177/1321103X14523531

Clark, T., and Williamon, A. (2011). Evaluation of a mental skills training program for musicians. *J. Appl. Sport Psychol.* 23, 342–359. doi: 10.1080/10413200.2011.574676

Clarke, L. K., Osborne, M. S., and Baranoff, J. A. (2020). Examining a group acceptance and commitment therapy intervention for music performance anxiety in student vocalists. *Front. Psychol.* 11:1127. doi: 10.3389/fpsyg.2020.01127

Cohen, S., and Bodner, E. (2019). Music performance skills: A two-pronged approach–facilitating optimal music performance and reducing music performance anxiety. *Psychol. Music* 47, 521–538. doi: 10.1177/0305735618765349

Conable, B., and Conable, W. (1995). *How to learn the Alexander technique: A manual for students*. Harrisburg, PA: Andover Press.

Cornett, V., and Urhan, G. (2021). Performance anxiety experiences and coping techniques of Turkish music students and their teachers. *Int. J. Music. Educ.* 39, 504–519. doi: 10.1177/02557614211005907

Coşkun-Şentürk, G., and Çırakoğlu, O. C. (2018). How guilt/shame proneness and coping styles are related to music performance anxiety and stress symptoms by gender. *Psychol. Music* 46, 682–698. doi: 10.1177/0305735617721338

Cox, W. J., and Kenardy, J. (1993). Performance anxiety, social phobia, and setting effects in instrumental music students. *J. Anxiety Disord.* 7, 49–60. doi: 10.1016/0887-6185(93)90020-L

Craske, M. G., and Craig, K. D. (1984). Musical performance anxiety: the three-systems model and self-efficacy theory. *Behav. Res. Ther.* 22, 267–280. doi: 10.1016/0005-7967(84)90007-X

Czajkowski, A.-M. L., Greasley, A. E., and Allis, M. (2020). Mindfulness for musicians: A mixed methods study investigating the effects of 8-week mindfulness courses on music students at a leading conservatoire. *Music. Sci.* 26, 259–279. doi: 10.1177/1029864920941570

De Felice, M. G. (2004). *Mindfulness meditation: A new tool for understanding and regulating musical performance anxiety. An affective neuroscientific perspective [DMA Dissertation]*. Coral Gables, FL: University of Miami.

de Figueiredo Rocha, S. (2020). Music performance anxiety: pilot study with gender endocrine biomarkers. *EC Psychol. Psychiatry* 9, 01–05.

Deen, D. R. (1999). *Awareness of breathing; keys to the moderation of MPA [Doctoral Dissertation]*. Lexington, KY: University of Kentucky.

Dempsey, E., and Comeau, G. (2019). Music performance anxiety and self-efficacy in young musicians: effects of gender and age. *Music Perform. Res.* 9, 60–79.

Diaz, F. M. (2018). Relationships among meditation, perfectionism, mindfulness, and performance anxiety among collegiate music students. *J. Res. Music. Educ.* 66, 150–167. doi: 10.1177/0022429418765447

Dilling, H., and Freyberger, H. J. (2015). *Taschenführer zur ICD10-Klassifikation psychischer Störungen. 8th Edn*. Göttingen: Hogrefe. (secondary source, cited in Osborne & Kirsner, 2022)

Dobos, B., Piko, B. F., and Kenny, D. T. (2019). Music performance anxiety and its relationship with social phobia and dimensions of perfectionism. *Res. Stud. Music Educ.* 41, 310–326. doi: 10.1177/1321103X18804295

Dobson, M. C. (2011). Insecurity, professional sociability, and alcohol: young freelance musicians' perspectives on work and life in the music profession. *Psychol. Music* 39, 240–260. doi: 10.1177/0305735610373562

Eisenberg, D., Downs, M. F., Golberstein, E., and Zivin, K. (2009). Stigma and help seeking for mental health among college students. *Med. Care Res. Rev.* 66, 522–541. doi: 10.1177/1077558709335173

Endo, S., Juhlberg, K., Bradbury, A., and Wing, A. M. (2014). Interaction between physiological and subjective states predicts the effect of a judging panel on the postures of cellists in performance. *Front. Psychol.* 5:773. doi: 10.3389/fpsyg.2014.00773

Engel, G. L. (1977). The need for a new medical model: A challenge for biomedicine. *Science* 196, 129–136. doi: 10.1126/science.847460

Errico, A. S. (2012). *The effects of a researcher-designed intervention on elementary students' music performance anxiety levels [Doctoral Dissertation]*. Boston, MA: Boston University.

Eysenck, M. W., and Calvo, M. G. (1992). Anxiety and performance: the processing efficiency theory. *Cognit. Emot.* 6, 409–434. doi: 10.1080/02699939208409696

Eysenck, M. W., Derakshan, N., Santos, R., and Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion* 7, 336–353. doi: 10.1037/1528-3542.7.2.336

Falkai, P., Wittchen, H. U., and Döpfner, M. (2015). *Diagnostisches und statistisches manual psychischer Störungen DSM-5®*. Göttingen: Hogrefe. (secondary source, cited in Osborne & Kirsner, 2022)

Farnsworth-Grodd, V. (2012). *Mindfulness and the self-regulation of music performance anxiety [Doctoral Dissertation]*. Auckland: Auckland University.

Faur, A. L., Pintea, S., Vaida, S., and Opre, A. N. (2022). The efficacy of cognitive and behavioral interventions upon music performance anxiety: a meta-analysis. *Psychol. Music* 51, 357–372. doi: 10.1177/03057356221115461

Fazey, J. A., and Hardy, L. (1988). "The inverted-U hypothesis: A catastrophe for sport psychology" in *British Association of Sports Sciences, monograph no. 1* (Leeds: National Coaching Foundation).

Fehm, L., and Schmidt, K. (2006). Performance anxiety in gifted adolescent musicians. *J. Anxiety Disord.* 20, 98–109. doi: 10.1016/j.janxdis.2004.11.011

Fernholz, I., Mumm, J. L. M., Plag, J., Noeres, K., Rotter, G., Willich, S. N., et al. (2019). Performance anxiety in professional musicians: A systematic review on prevalence, risk factors and clinical treatment effects. *Psychol. Med.* 49, 2287–2306. doi: 10.1017/S0033291719001910

Finch, K., and Moscovitch, D. (2016). Imagery-based interventions for music performance anxiety: an integrative review. *Med. Probl. Perform. Art.* 31, 222–231. doi: 10.21091/mppa.2016.4040

Finch, K. K., and Oakman, J. M. (2022). "Applied mental imagery and music performance anxiety" in *Music and mental imagery*. eds. Mats, B. Küssner, Liila, Taruffi, Georgia, A. Floridou (Abingdon: Routledge), 221–230.

Fishbein, M., Middlestadt, S. E., Ottati, V., Straus, S., and Ellis, A. (1988). Medical problems among ICSOM musicians: overview of a national survey. *Med. Probl. Perform. Art.* 3, 1–8.

Ford, J., and Arvinen-Barrow, M. (2019). Exploring the use of psychological skills training interventions in a music domain: A systematic review. *Med. Probl. Perform. Art.* 34, 222–229. doi: 10.21091/mppa.2019.4033

Frost, R. O., Heimberg, R. G., Holt, C. S., Mattia, J. I., and Neubauer, A. L. (1993). A comparison of two measures of perfectionism. *Personal. Individ. Differ.* 14, 119–126. doi: 10.1016/0191-8869(93)90181-2

Gannon, P. (2019). Is it anxiety or arousal that can facilitate musical performance? *Med. Probl. Perform. Art.* 34, 118–119. doi: 10.21091/mppa.2019.2018

Gembris, H., and Heye, A. (2012). Älter werden im Orchester. *Institut Für Begabungsforschung in Der Musik* 18, 371–391. doi: 10.1177/1029864914548912

Gembris, H., Heye, A., and Seifert, A. (2018). Health problems of orchestral musicians from a life-span perspective: results of a large-scale study. *Music Sci.* 1, 1–20. doi: 10.1177/2059204317739801

Ginsborg, J. (2019). Managing music performance anxiety. *Am Music Teacher* 68, 16–18.

Ginsborg, J., Kreutz, G., Thomas, M., and Williamon, A. (2009). Healthy behaviours in music and non-music performance students. *Health Educ.* 109, 242–258. doi: 10.1108/09654280910955575

Gomez, P., Nielsen, C., Studer, R. K., Hildebrandt, H., Klumb, P. L., Nater, U. M., et al. (2018). Prolonged performance-related neuroendocrine activation and perseverative cognition in low- and high-anxious university music students. *Psychoneuroendocrinology* 95, 18–27. doi: 10.1016/j.psyneuen.2018.05.018

González, A., Blanco-Piñeiro, P., and Díaz-Pereira, M. P. (2018). Music performance anxiety: exploring structural relations with self-efficacy, boost, and self-rated performance. *Psychol. Music* 46, 831–847. doi: 10.1177/0305735617727822

Goren, L. (2014). *A meta-analysis of nonpharmacologic psychotherapies for music performance anxiety [Doctoral Dissertation]*. San Francisco, CA: California Institute of Integral Studies.

Greene, D. (2012). *Performance success*. Abingdon: Routledge Ltd.

Grindea, C. (1984). *Tensions in the performance of music: A symposium*. New York: Alexander Broude.

Gross, J. J. (2015). Emotion regulation: current status and future prospects. *Psychol. Inq.* 26, 1–26. doi: 10.1080/1047840X.2014.940781

Gross, S. A., and Musgrave, G. (2016). *Can music make you sick? Music and depression (A Study into the Incidence of Musicians' Mental Health)*. pp. 1–69). London: Help Musicians UK.

Guyon, A. J. A. A., Cannavò, R., Studer, R. K., Hildebrandt, H., Danuser, B., Vlemincx, E., et al. (2020). Respiratory variability, sighing, anxiety, and breathing symptoms in low- and high-anxious music students before and after performing. *Front. Psychol.* 11:303. doi: 10.3389/fpsyg.2020.00303

Halleland, H. B., Harris, A., Sørnes, S., Murison, R., and Ursin, H. (2009). Subjective health complaints, stress, and coping in orchestra musicians. *Med. Probl. Perform. Art.* 24, 58–62. doi: 10.21091/mppa.2009.2014

Hamann, D. L. (1982). An assessment of anxiety in instrumental and vocal performances. *J. Res. Music. Educ.* 30, 77–90. doi: 10.2307/3345040

Hamann, D. L. (1985). The other side of stage fright. *Music. Educ. J.* 71, 26–28. doi: 10.2307/3396494

Hamann, D. L., and Sobaje, M. (1983). Anxiety and the college musician: a study of performance conditions and subject variables. *Psychol. Music* 11, 37–50. doi: 10.1177/0305735683111005

Hardy, L., and Parfitt, G. (1991). A catastrophe model of anxiety and performance. *Br. J. Psychol.* 82, 163–178. doi: 10.1111/j.2044-8295.1991.tb02391.x

Harper, B. S. (2002). Workplace and health: a survey of classical orchestral musicians in the United Kingdom and Germany. *Med. Probl. Perform. Art.* 17, 83–92. doi: 10.21091/mppa.2002.2012

Harris, S. R. (1986). A psychologist Viéws musical performance anxiety. *Am. Music Teacher* 35:24.

Hatfield, J. L. (2016). Performing at the top of One's musical game. *Front. Psychol.* 7:1356. doi: 10.3389/fpsyg.2016.01356

Hays, K. F. (2009). *Performance psychology in action: A casebook for working with athletes, performing artists, business leaders, and professionals in high-risk occupations*. Washington, DC: American Psychological Association.

Helding, L. (2016). Music performance anxiety. *J. Sing.* 73, 83–90.

Hernández, S. O., Zarza-Alzugaray, F. J., and Casanova, O. (2018). Music performance anxiety. Substance use and career abandonment in Spanish music students. *Int. J. Music. Educ.* 36, 460–472. doi: 10.1177/0255761418763903

Hewitt, P. L., and Flett, G. L. (1991). Perfectionism in the self and social contexts: conceptualization, assessment, and association with psychopathology. *J. Pers. Soc. Psychol.* 60, 456–470. doi: 10.1037/0022-3514.60.3.456

Hildebrandt, H. (2009). "Teaching music physiology and motor learning processes at a university: experience and evaluation" in *Art in motion. Musical and athletic motor learning and performance*. ed. A. Mornell (Frankfurt: Peter Lang), 191–222.

Hildebrandt, H., and Nübling, M. (2004). Providing further training in musicophysiology to instrumental teachers: do their professional and preprofessional students derive any benefit? *Med. Probl. Perform. Art.* 19, 62–69. doi: 10.21091/mppa.2004.2010

Hildebrandt, H., Nübling, M., and Candia, V. (2012). Increment of fatigue, depression, and stage fright during the first year of high-level education in music students. *MPPA* 27, 43–48. doi: 10.21091/mppa.2012.1008

Hitchcock, P. F., Martin, L. M., Fischer, L., Marando-Blanck, S., and Herbert, J. D. (2016). Popular conceptions of mindfulness: awareness and emotional control. *Mindfulness* 7, 940–949. doi: 10.1007/s12671-016-0533-9

Hoffman, S. L., and Hanrahan, S. J. (2012). Mental skills for musicians: managing music performance anxiety and enhancing performance. *Sport Exerc. Perform. Psychol.* 1, 17–28. doi: 10.1037/a0025409

Horvath, J. (2001). An orchestra musician's perspective on 20 years of performing arts medicine. *Med. Probl. Perform. Art.* 16, 102–108. doi: 10.21091/mppa.2001.3018

Huang, W.-L., and Song, B. (2021). How do college musicians self-manage musical performance anxiety: strategies through time periods and types of performance. *Int. J. Music. Educ.* 39, 95–118. doi: 10.1177/0255761421990800

James, I. (1998). Western orchestral musicians are highly stressed. *Resonance Int. Music Council* 26, 19–20.

James, I. M. (2000). "Survey of orchestras" in *Medical problems of the instrumentalist musician*. eds. R. Tubiana and P. C. Amadio (London: Martin Dunitz), 195–201.

James, I., and Savage, I. (1983). A comparison of the effects on musical performance of two methods designed to reduce situational anxiety. *J. Int. Society Study Tension Perform.* 1, 34–38.

Jones, G., and Swain, A. (1992). Intensity and direction as dimensions of competitive state anxiety and relationships with competitiveness. *Percept. Mot. Skills* 74, 467–472. doi: 10.2466/pms.1992.74.2.467

Juncos, D. G., and Markman, E. J. (2016). Acceptance and commitment therapy for the treatment of music performance anxiety: A single subject design with a university student. *Psychology of Music*, 44, 935–953.

Juncos, D. G., and de Paiva e Pona, E. (2018). Acceptance and commitment therapy as a clinical anxiety treatment and performance enhancement program for musicians: towards an evidence-based practice model within performance psychology. *Music Sci.* 1:205920431774880. doi: 10.1177/2059204317748807

Juncos, D. G., and de Paiva e Pona, E. (2022). *ACT for musicians: A guide for using acceptance and commitment training to enhance performance, overcome performance anxiety, and improve well-being*. Irvine, CA: Universal-Publishers.

Juncos, D. G., Heinrichs, G. A., Towle, P., Duffy, K., Grand, S. M., Morgan, M. C., et al. (2017). Acceptance and commitment therapy for the treatment of music performance anxiety: A pilot study with student vocalists. *Front. Psychol.* 8:986. doi: 10.3389/fpsyg.2017.00986

Kageyama, N. J. (2022). Why trying to calm down backstage could backfire. Bulletproof Musician. Available at: https://bulletproofmusician.com/what-leads-to-better-performances-telling-yourself-to-calm-down-or-get-excited/

Kantor-Martynuska, J., Domaradzka, E., Kenny, D. T., and Holmes, J. (2018). Performance anxiety: the need for an integrative approach. *Pol. Psychol. Bull.* 19, 272–282. doi: 10.24425/119495

Kaspersen, M., and Götestam, K. G. (2002). A survey of music performance anxiety among Norwegian music students. *Europ. J. Psychiatry* 16, 69–80.

Kelley, J., and Farley, A. (2019). Self-compassion levels in music and non-music students. *Contrib. Music. Educ.* 44, 167–184.

Kendrick, M. J., Craig, K. D., Lawson, D. M., and Davidson, P. O. (1982). Cognitive and behavioral therapy for musical-performance anxiety. *J. Consult. Clin. Psychol.* 50, 353–362. doi: 10.1037/0022-006X.50.3.353

Kenny, D. T. (2004). Music performance anxiety: is it the music, the performance or the anxiety. *Music Forum* 10, 38–43.

Kenny, D. T. (2005). A systematic review of treatments for music performance anxiety. *Anxiety Stress Coping* 18, 183–208. doi: 10.1080/10615800500167258

Kenny, D. T. (2006). Music performance anxiety: origins, phenomenology, assessment and treatment. *Context J. Music Res.* 31, 51–64.

Kenny, D. T. (2009). "Negative emotions in music making: performance anxiety" in *Handbook of music and emotion: Theory, research, applications*. eds. P. N. Juslin and J. A. Sloboda (Oxford: Oxford University Press), 425–451.

Kenny, D. (2011). *The psychology of music performance anxiety*. Oxford: Oxford University Press.

Kenny, D., and Ackermann, B. (2015). Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: A population study. *Psychol. Music* 43, 43–60. doi: 10.1177/0305735613493953

Kenny, D. T., Davis, P., and Oates, J. (2004). Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J. Anxiety Disord.* 18, 757–777. doi: 10.1016/j.janxdis.2003.09.004

Kenny, D., Driscoll, T., and Ackermann, B. (2014). Psychological well-being in professional orchestral musicians in Australia: A descriptive population study. *Psychol. Music* 42, 210–232. doi: 10.1177/0305735612463950

Kenny, D., Driscoll, T., and Ackermann, B. (2016). Is playing in the pit really the pits?: pain, strength, music performance anxiety, and workplace satisfaction in professional musicians in stage, pit, and combined stage/pit orchestras. *Med. Probl. Perform. Art.* 31, 1–7. doi: 10.21091/mppa.2016.1001

Kenny, D. T., and Holmes, J. (2015). Exploring the attachment narrative of a professional musician with severe performance anxiety: A case report. *J. Psychol. Psychother.* 5, 1–6. doi: 10.4172/2161-0487.1000190

Kenny, D. T., and Holmes, J. (2018). Attachment quality is associated with music performance anxiety in professional musicians: an exploratory narrative study. *Pol. Psychol. Bull.* 49, 283–298. doi: 10.24425/119496

Kenny, D. T., and Osborne, M. S. (2006). Music performance anxiety: new insights from young musicians. *Adv. Cogn. Psychol.* 2, 103–112. doi: 10.2478/v10053-008-0049-5

Khalsa, S. B. S., Shorter, S. M., Cope, S., Wyshak, G., and Sklar, E. (2009). Yoga ameliorates performance anxiety and mood disturbance in young professional musicians. *Appl. Psychophysiol. Biofeedback* 34, 279–289. doi: 10.1007/s10484-009-9103-4

Kiik-Salupere, V., and Ross, J. (2020). "How professional and student singers Cope with performance anxiety" in *The Routledge companion to interdisciplinary studies in singing*, vol. *2*, Eds. Helga, R. Gudmundsdottir, Carol, Beynon, Karen, Ludke, Annabel, J.Cohen (Abingdon: Routledge), 241–252.

Kim, Y. (2008). The effect of improvisation-assisted desensitization, and music-assisted progressive muscle relaxation and imagery on reducing pianists' music performance anxiety. *J. Music. Ther.* 45, 165–191. doi: 10.1093/jmt/45.2.165

Kirchner, J. M. (2003). A qualitative inquiry into musical performance anxiety. *Med. Probl. Perform. Art.* 18, 78–82. doi: 10.21091/mppa.2003.2015

Kirsner, J., Wilson, S. J., and Osborne, M. S. (2023). Music performance anxiety: the role of early parenting experiences and cognitive schemas. *Front. Psychol.* 14:1185296. doi: 10.3389/fpsyg.2023.1185296

Kivimäki, M., and Jokinen, M. (1994). Job perceptions and well-being among symphony orchestra musicians: A comparison with other occupational groups. *Med. Probl. Perform. Art.* 9, 73–76.

Kobori, O., Yoshie, M., Kudo, K., and Ohtsuki, T. (2011). Traits and cognitions of perfectionism and their relation with coping style, effort, achievement, and performance anxiety in Japanese musicians. *J. Anxiety Disord.* 25, 674–679. doi: 10.1016/j.janxdis.2011.03.001

Kreutz, G., Ginsborg, J., and Williamon, A. (2008). Music students' health problems and health-promoting behaviours. *Med. Probl. Perform. Art.* 23, 3–11. doi: 10.21091/mppa.2008.1002

Langendörfer, F., Hodapp, V., Kreutz, G., and Bongard, S. (2006). Personality and performance anxiety among professional orchestra musicians. *J. Individ. Differ.* 27, 162–171. doi: 10.1027/1614-0001.27.3.162

Lawrence, M. (2019). *Music performance anxiety as hidden desire and emerging self: The development and exploration of a conceptual lens for performers and practitioners [Doctoral Dissertation]*. London: Guildhall School of Music & Drama.

Lazarus, R. S. (2006). *Stress and emotion: A new synthesis*. New York: Springer publishing company.

Lazarus, A. A., and Abramovitz, A. (2004). A multimodal behavioral approach to performance anxiety. *J. Clin. Psychol.* 60, 831–840. doi: 10.1002/jclp.20041

Lazarus, R. S., and Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer publishing company.

Lederman, R. J. (1999). Medical treatment of performance anxiety: A statement in favor. *Med. Probl. Perform. Art.* 14, 117–121.

Lehrer, P. M. (1987). A review of the approaches to the Management of Tension and Stage Fright in music performance. *J. Res. Music. Educ.* 35, 143–153. doi: 10.2307/3344957

Lehrer, P. M., Goldman, N. S., and Strommen, E. F. (1990). A principal components assessment of performance anxiety among musicians. *Med. Probl. Perform. Art.* 5, 12–18.

Lehrer, P. M., and Woolfolk, R. L. (1982). Self-report assessment of anxiety: somatic, cognitive, and behavioral modalities. *Behav. Assess.* 4, 167–177.

Lin, P., Chang, J., Zemon, V., and Midlarsky, E. (2008). Silent illumination: A study on Chan (zen) meditation, anxiety, and musical performance quality. *Psychol. Music* 36, 139–155. doi: 10.1177/0305735607080840

Liston, M., Frost, A. A., and Mohr, P. B. (2003). The prediction of musical performance anxiety. *Med. Probl. Perform. Art.* 18, 120–125. doi: 10.21091/mppa.2003.3021

Lockwood, A. H. (1989). Medical problems of musicians. *N. Engl. J. Med.* 320, 221–227. doi: 10.1056/NEJM198901263200405

Logan, E. C. (2022). *Managing music performance anxiety: A performer's perspective*. Kelowna, BC: University of British Columbia.

Lupiáñez, M., Ortiz, F. D. P., Vila, J., and Muñoz, M. A. (2022). Predictors of music performance anxiety in conservatory students. *Psychol. Music* 50, 1005–1022. doi: 10.1177/03057356211032290

Lyon, N., and Plisco, M. (2020). The effects of self-compassion and mindfulness on performance anxiety and flow in elite athletes. *J. Sport Behav.* 43, 426–441.

MacAfee, E., and Comeau, G. (2022). Teacher perspective on music performance anxiety: an exploration of coping strategies used by music teachers. *Br. J. Music Educ.* 40, 34–53. doi: 10.1017/S0265051722000146

MacNamara, Á., Holmes, P., and Collins, D. (2008). Negotiating transitions in musical development: the role of psychological characteristics of developing excellence. *Psychol. Music* 36, 335–352. doi: 10.1177/0305735607086041

Mahony, S., Juncos, D. G., and Winter, D. (2022). Acceptance and commitment coaching for music performance anxiety: piloting a six-week group course with undergraduate dance & musical theatre students. *Front. Psychol.* 13:230. doi: 10.3389/fpsyg.2022.830230

Manchester, R. A. (2011). The biopsychosocial model and performing arts medicine. *Med. Probl. Perform. Art.* 26, 121–122. doi: 10.21091/mppa.2011.3020

Matei, R., Broad, S., Goldbart, J., and Ginsborg, J. (2018). Health education for musicians. *Front. Psychol.* 9:1137. doi: 10.3389/fpsyg.2018.01137

Matei, R., and Ginsborg, J. (2017). Music performance anxiety in classical musicians – what we know about what works. *BJPsych. Int.* 14, 33–35. doi: 10.1192/S2056474000001744

Mazzarolo, I., Burwell, K., and Schubert, E. (2023). Teachers' approaches to music performance anxiety management: A systematic review. *Front. Psychol.* 14:1205150. doi: 10.3389/fpsyg.2023.1205150

McCarty, R. (2016). "Chapter 4- the fight-or-flight response: A cornerstone of stress research" in *Stress: Concepts, cognition, emotion, and behavior*. ed. G. Fink, vol. *1* (Cambridge, MA: Academic Press), 33–37.

McGinnis, A. M., and Milling, L. S. (2005). Psychological treatment of musical performance anxiety: current status and future directions. *Psychother. Theory Res. Pract. Train.* 42, 357–373. doi: 10.1037/0033-3204.42.3.357

McGrath, C. (2012). *Music performance anxiety therapies: A review of the literature [Doctoral Dissertation]*. Champaign, IL: University of Illinois at Urbana-Champaign.

McNeil, D. G., Loi, N. M., and Bullen, R. (2022). Investigating the moderating role of coping style on music performance anxiety and perfectionism. *Int. J. Music. Educ.* 40, 587–597. doi: 10.1177/02557614221080523

Middlestadt, S. E. (1990). Medical problems of symphony orchestra musicians: from counting people with problems to evaluating interventions. *Revista Interamericana de Psicología* 24, 159–172.

Miller, S. R., and Chesky, K. (2004). The multidimensional anxiety theory: an assessment of and relationships between intensity and direction of cognitive anxiety, somatic anxiety, and self-confidence over multiple performance requirements among college music majors. *Med. Probl. Perform. Art.* 19, 12–20. doi: 10.21091/mppa.2004.1003

Mitchell, N. (2011). Evaluation and performance anxiety in music study. *Can. Music. Educ.* 53, 32–34.

Montello, L. (1989). *Utilizing music therapy as a mode of treatment for the performance stress of professional musicians [Doctoral Dissertation]*. New York: New York University.

Montello, L., Coons, E. E., and Kantor, J. (1990). The use of music therapy as a treatment for musical performance stress. *Med. Probl. Perform. Art.* 5:49.

Mor, S., Day, H., Flett, G. L., and Hewitt, P. L. (1995). Perfectionism, control, and components of performance anxiety in professional artists. *Cogn. Ther. Res.* 19, 207–225. doi: 10.1007/bf02229695

Moreno-Gutierréz, J. A., López-González, M. V., de Rojas Leal, C., Chao-Ecija, A., and Dawid-Milner, M. S. (2023). Impact of music performance anxiety on cardiovascular blood pressure responses, autonomic tone and baroreceptor sensitivity to a western classical music piano-concert. *Front. Neurosci.* 17:1213117. doi: 10.3389/fnins.2023.1213117

Mornell, A., and Wulf, G. (2019). Adopting an external focus of attention enhances musical performance. *J. Res. Music. Educ.* 66, 375–391. doi: 10.1177/0022429418801573

Moura, N., and Serra, S. (2021). Listening to teachers' voices: constructs on music performance anxiety in artistic education. *J. Sci. Technol. Arts* 13, 99–117. doi: 10.34632/jsta.2021.9853

Mumm, J., Fernholz, I., Ströhle, A., Plag, J., and Schmidt, A. (2020). Performance anxiety among musicians. *Z. Neuropsychol.* 31, 76–80. doi: 10.1024/1016-264X/a000294

Nagel, J. J. (1990). Performance anxiety and the performing musician: A fear of failure or a fear of success. *Med. Probl. Perform. Art.* 5, 37–40.

Nagel, J. J. (1993). Stage fright in musicians: A psychodynamic perspective. *Bull. Menn. Clin.* 57, 492–503.

Nagel, J. J. (2010). Treatment of music performance anxiety via psychological approaches. *Med. Probl. Perform. Art.* 25, 141–148. doi: 10.21091/mppa.2010.4031

Nagel, J. J., Himle, D. P., and Papsdorf, J. D. (1989). Cognitive-behavioural treatment of musical performance anxiety. *Psychol. Music* 17, 12–21. doi: 10.1177/0305735689171002

Neftel, K. A., Adler, R. H., Kappeli, L., Rossi, M., Dolder, M., Kaser, H. E., et al. (1982). Stage fright in musicians: A model illustrating the effect of beta blockers. *Psychosom. Med.* 44, 461–469. doi: 10.1097/00006842-198211000-00008

Nicholson, D. R., Cody, M. W., and Beck, J. G. (2015). Anxiety in musicians: on and off stage. *Psychol. Music* 43, 438–449. doi: 10.1177/0305735614540018

Nielsen, C., Studer, R. K., Hildebrandt, H., Nater, U. M., Wild, P., Danuser, B., et al. (2018). The relationship between music performance anxiety, subjective performance quality and post-event rumination among music students. *Psychol. Music* 46, 136–152. doi: 10.1177/0305735617706539

Niemann, B. K., Pratt, R. R., and Maughan, M. L. (1993). Biofeedback training, selected coping strategies, and music relaxation interventions to reduce debilitative musical performance anxiety. *Int. J. Arts Med.* 2, 7–15.

Nordin-Bates, S. M. (2012). "Performance psychology in the performing arts" in *The Oxford handbook of sport and performance psychology*, Eds. S. M. Murphy (Oxford: Oxford University Press), 81–114.

Norton, G. R., MacLean, L., and Wachna, E. (1978). The use of cognitive desensitization and self-directed mastery training for treating stage fright. *Cogn. Ther. Res.* 2, 61–64. doi: 10.1007/BF01172513

Orejudo, S., Zarza-Alzugaray, F. J., Casanova, O., Rodríguez-Ledo, C., and Mazas, B. (2017). The relation of music performance anxiety (MPA) to optimism, self-efficacy, and sensitivity to reward and punishment: testing Barlow's theory of personal vulnerability on a sample of Spanish music students. *Psychol. Music* 45, 570–583. doi: 10.1177/0305735616674791

Osborne, M. S., and Franklin, J. (2002). Cognitive processes in music performance anxiety. *Aust. J. Psychol.* 54, 86–93. doi: 10.1080/00049530210001706543

Osborne, M., Glasser, S., and Loveridge, B. (2022). *'It's not so scary anymore. It's actually exhilarating': A proof-of-concept study using virtual reality technology for music performance training under pressure*. Sydney: ASCILITE Publications. e22116.

Osborne, M. S., Greene, D. J., and Immel, D. T. (2014). Managing performance anxiety and improving mental skills in conservatoire students through performance psychology training: A pilot study. *Psychol. Well-Being* 4:18. doi: 10.1186/s13612-014-0018-3

Osborne, M. S., and Kenny, D. T. (2005). Development and validation of a music performance anxiety inventory for gifted adolescent musicians. *J. Anxiety Disord.* 19, 725–751. doi: 10.1016/j.janxdis.2004.09.002

Osborne, M. S., and Kenny, D. T. (2008). The role of sensitizing experiences in music performance anxiety in adolescent musicians. *Psychol. Music* 36, 447–462. doi: 10.1177/0305735607086051

Osborne, M. S., Kenny, D. T., and Cooksey, J. (2007). Impact of a cognitive-behavioural treatment program on music performance anxiety in secondary school music students: A pilot study. *Music. Sci.* 11, 53–84. doi: 10.1177/10298649070110S204

Osborne, M. S., and Kirsner, J. (2022). "Music performance anxiety" in *The Oxford handbook of music performance*. ed. G. E. McPherson, vol. *2* (Oxford: Oxford University Press), 204–231.

Osborne, M. S., and McPherson, G. E. (2019). Precompetitive appraisal, performance anxiety and confidence in conservatorium musicians: A case for coping. *Psychol. Music* 47, 451–462. doi: 10.1177/0305735618755000

Osborne, M. S., Munzel, B., and Greenaway, K. H. (2020). Emotion goals in music performance anxiety. *Front. Psychol.* 11:1138. doi: 10.3389/fpsyg.2020.01138

Oudejans, R. R. D., Spitse, A., Kralt, E., and Bakker, F. C. (2017). Exploring the thoughts and attentional focus of music students under pressure. *Psychol. Music* 45, 216–230. doi: 10.1177/0305735616656790

Oyan, S. (2006). Mindfulness meditation: Creative musical performance through awareness. [DMA dissertation]. Available at: https://www.proquest.com/openview/06698276f6c99dc535fd28ed6c1ef4c4/1?pq-origsite=gscholar&cbl=18750&diss=y

Papageorgi, I. (2020). Prevalence and predictors of music performance anxiety in adolescent learners: contributions of individual, task-related and environmental factors. *Music. Sci.* 26:3128. doi: 10.1177/1029864920923128

Papageorgi, I., Haddon, E., Creech, A., Morton, F., Bezenac, C. D., Himonides, E., et al. (2010). Institutional culture and learning II: inter-relationships between perceptions of the learning environment and undergraduate musicians' attitudes to performance. *Music. Educ. Res.* 12, 427–446. doi: 10.1080/14613808.2010.520432

Papageorgi, I., Hallam, S., and Welch, G. F. (2007). A conceptual framework for understanding musical performance anxiety. *Res. Stud. Music Educ.* 28, 83–107. doi: 10.1177/1321103X070280010207

Parasuraman, S., and Purohit, Y. S. (2000). Distress and boredom among orchestra musicians: the two faces of stress. *J. Occup. Health Psychol.* 5, 74–83. doi: 10.1037/1076-8998.5.1.74

Park, J.-E. (2010). *The Relationshiop between musical performance anxiety, healthy lifestyle factors, and substance use among young adult classical musicians: Implications for training and education [PhD Thesis]*. New York, NY: Columbia University.

Patson, T., and Loughlan, T. (2014). Playing with performance: the use and abuse of beta-blockers in the performing arts. *Victorian J. Music Educ.* 1, 3–10.

Pecen, E. (2019). *Development of an evidence-based psychological skills training program for professional music performance [Doctoral]*. Preston: University of Central Lancashire.

Pecen, E., Collins, D., and Mac Namara, Á. (2016). Music of the night: performance practitioner considerations for enhancement work in music. *Sport Exerc. Perform. Psychol.* 5, 377–395. doi: 10.1037/spy0000067

Pecen, E., Collins, D. J., and Mac Namara, Á. (2018). "It's your problem. Deal with it." performers' experiences of psychological challenges in music. *Front. Psychol.* 8:2374. doi: 10.3389/fpsyg.2017.02374

Pell, D. R. (2020). *Insulating musical motor skills against music performance anxiety [PhD Thesis]*. Toronto: University of Toronto (Canada).

Perdomo-Guevara, E. (2014). Is music performance anxiety just an individual problem? Exploring the impact of musical environments on performers' approaches to performance and emotions. *Psychomusicology* 24, 66–74. doi: 10.1037/pmu0000028

Pfeifer, E., Stolterfoth, C., Spahn, C., Schmidt, H. U., Timmermann, T., and Wittmann, M. (2020). Preventing music performance anxiety (MPA): music students judge combined depth relaxation music therapy (DRMT) and silence to be an effective methodology. *Music and Medicine* 12:148. doi: 10.47513/mmd.v12i3.688

Plott, T. M. (1986). *An investigation of the hypnotic treatment of music performance anxiety [PhD Thesis]*. University of Tennessee, Knoxville.

Powell, D. H. (2004). Treating individuals with debilitating performance anxiety: an introduction. *J. Clin. Psychol.* 60, 801–808. doi: 10.1002/jclp.20038

Reubart, D. (1985). *Anxiety and musical performance: On playing the piano from memory*. Cambridge, MA: Da Capo Press.

Rider, M. S. (1987). Music therapy: therapy for debilitated musicians. *Music. Ther. Perspect.* 4, 40–43. doi: 10.1093/mtp/4.1.40

Rife, N. A., Lapidus, L. B., and Shnek, Z. M. (2000). Musical performance anxiety, cognitive flexibility, and field independence in professional musicians. *Med. Probl. Perform. Art.* 15, 161–167.

Roland, D. (1994). How professional performers manage performance anxiety. *Res. Stud. Music Educ.* 2, 25–35. doi: 10.1177/1321103X9400200105

Ruggiero, M. (2012). *Using attentional control theory to account for anxiety-related errors on musical performance tasks [Doctoral Dissertation]*. Perth: Curtin University.

Rumsey, H. (2015). Anxiety's effect on muscle activation and fatigue in trumpet players: A pilot study. *Med. Probl. Perform. Art.* 30, 203–210. doi: 10.21091/mppa.2015.4038

Sabino, A. D., Chagas, M. H. N., and Osório, F. L. (2020). Acute effects of oxytocin in music performance anxiety: A crossover, randomized, placebo-controlled trial. *Psychopharmacology* 237, 1–11. doi: 10.1007/s00213-020-05493-0

Sadler, M. E., and Miller, C. J. (2010). Performance anxiety: A longitudinal study of the roles of personality and experience in musicians. *Soc. Psychol. Personal. Sci.* 1, 280–287. doi: 10.1177/1948550610370492

Safirstein, L. (1962). Stage fright in a musician: a segment of an analysis. *Am. J. Psychoanal.* 22, 15–42. doi: 10.1007/BF01871614

Salmon, P. G. (1990). A psychological perspective on musical performance anxiety: a review of the literature. *Med. Probl. Perform. Art.* 5, 2–11.

Salmon, P. G. (1992). Performance anxiety. In *Comprehensive casebook of cognitive therapy* (FreemanA. In and F. M. Dattilio (eds), pp. 61–69). New York: Plenum Press.

Salmon, P. G., and Meyer, R. G. (1992). *Notes from the green room: Coping with stress and anxiety in musical performance*. Princeton, NJ: Maxwell Macmillan Int.

Sarıkaya, M., and Kurtaslan, Z. (2018). Prediction of musical performance anxiety according to music teacher candidates' perfectionism and self-efficacy beliefs. *Int. Online J. Educ. Sci.* 10:10. doi: 10.15345/iojes.2018.04.010

Sataloff, R. T., Rosen, D. C., and Levy, S. (1999). Medical treatment of performance anxiety: A comprehensive approach. *Med. Probl. Perform. Art.* 14, 122–126.

Schanche, E., Vøllestad, J., Binder, P.-E., Hjeltnes, A., Dundas, I., and Nielsen, G. H. (2020). Participant experiences of change in mindfulness-based stress reduction for anxiety disorders. *Int. J. Qual. Stud. Health Well Being* 15:1776094. doi: 10.1080/17482631.2020.1776094

Schuele, S. U., and Lederman, R. J. (2004). Occupational disorders in instrumental musicians. *Med. Probl. Perform. Art.* 19, 123–128. doi: 10.21091/mppa.2004.3021

Senyshyn, Y. (1999). Perspectives on performance and anxiety and their implications for creative teaching. *Canadian J. Educ.* 24, 30–41. doi: 10.2307/1585769

Senyshyn, Y., and O'Neill, S. A. (2001). Subjective experience of anxiety and musical performance: A relational perspective. *Philos. Music Educ. Rev.* 9, 42–53.

Shaw, T. A., Juncos, D. G., and Winter, D. (2020). Piloting a new model for treating music performance anxiety: training a singing teacher to use acceptance and commitment coaching with a student. *Front. Psychol.* 11:882. doi: 10.3389/fpsyg.2020.00882

Simoens, V. L., Puttonen, S., and Tervaniemi, M. (2015). Are music performance anxiety and performance boost perceived as extremes of the same continuum? *Psychol. Music* 43, 171–187. doi: 10.1177/0305735613499200

Sinden, L. M. (1999). *Music performance anxiety: Contributions of perfectionism, coping style, self-efficacy, and self-esteem* (*60*, 590. Tempe, AZ: Arizona State University.

Skoogh, F., and Frisk, H. (2019). Performance values – an artistic research perspective on music performance anxiety in classical music. *J. Res. Arts Sports Educ.* 3, 1–15. doi: 10.23865/jased.v3.1506

Smith, A. J., and Rickard, N. S. (2004). Prediction of music performance anxiety via personality and trait anxiety in young musicians. *Aust. J. Music. Educ.* 1, 3–12.

Sokoli, E., Hildebrandt, H., and Gomez, P. (2022). Classical music students' pre-performance anxiety, catastrophizing, and bodily complaints vary by age, gender, and instrument and predict self-rated performance quality. *Front. Psychol.* 13:905680. doi: 10.3389/fpsyg.2022.905680

Sousa, C. M., Machado, J. P., Greten, H. J., and Coimbra, D. (2016). Occupational diseases of professional orchestra musicians from northern Portugal: A descriptive study. *Med. Probl. Perform. Art.* 31, 8–12. doi: 10.21091/mppa.2016.1002

Spahn, C., Richter, B., and Zschocke, I. (2002). Health attitudes, preventive behavior, and playing-related health problems among music students. *Medical Problems of Performing Artists*. 17, 22–28. doi: 10.21091/mppa.2002.1004

Spahn, C. (2015). "Treatment and prevention of music performance anxiety" in *Music, neurology, and neuroscience: Evolution, the musical brain, medical conditions, and therapies*. eds. E. Altenmueller, S. Finger and F. Boller, vol. *217* (Amsterdam: Elsevier), 129–140.

Spahn, C., Echternach, M., Zander, M. F., Voltmer, E., and Richter, B. (2010). Music performance anxiety in opera singers. *Logopedics Phoniatrics Vocol.* 35, 175–182. doi: 10.3109/14015431003720600

Spahn, C., Walther, J.-C., and Nusseck, M. (2016). The effectiveness of a multimodal concept of audition training for music students in coping with music performance anxiety. *Psychol. Music* 44, 893–909. doi: 10.1177/0305735615597484

Spielberger, C. D. (1983). *State-trait anxiety inventory for adults (STAI-AD) [database record]. APA PsycTests*. American Psychological Association: Washington, DC.

Spielberger, C. D. (2013). *Anxiety: Current trends in theory and research*. Amsterdam: Elsevier.

Stanson, N. (2019). *The effectiveness of mindfulness training on young adult musicians experiencing music performance anxiety [Master's thesis]*. Ottawa: University of Ottawa.

Stanton, H. E. (1993). Alleviation of performance anxiety through hypnotherapy. *Psychol. Music* 21, 78–82. doi: 10.1177/030573569302100106

Stephenson, H., and Quarrier, N. F. (2005). Anxiety sensitivity and performance anxiety in college music students. *Med. Probl. Perform. Art.* 20, 119–125. doi: 10.21091/mppa.2005.3024

Steptoe, A. (1982). Performance anxiety. Recent developments in its analysis and management. *The Musical Times* 123, 537–541. doi: 10.2307/962763

Steptoe, A. (1989). Stress, coping and stage fright in professional musicians. *Psychol. Music* 17, 3–11. doi: 10.1177/0305735689171001

Steptoe, A. (2001). "Negative emotions in music making: the problem of performance anxiety" in *Music and emotion: Theory and research*, eds. P. N. Juslin and J. A. Sloboda (Oxford: Oxford University Press), 291–307.

Steptoe, A., and Fidler, H. (1987). Stage fright in orchestral musicians: A study of cognitive and behavioural strategies in performance anxiety. *Br. J. Psychol.* 78, 241–249. doi: 10.1111/j.2044-8295.1987.tb02243.x

Stern, J. R., Khalsa, S. B. S., and Hofmann, S. G. (2012). A yoga intervention for music performance anxiety in conservatory students. *Med. Probl. Perform. Art.* 27, 123–128. doi: 10.21091/mppa.2012.3023

Sternbach, D. J. (1993). Addressing stress-related illness in professional musicians. *Maryland Med. J.* 42, 283–288.

Sternbach, D. J. (2008). Stress in the lives of music students. *Music. Educ. J.* 94, 42–48. doi: 10.1177/002743210809400309

Stoeber, J., and Eismann, U. (2007). Perfectionism in young musicians: relations with motivation, effort, achievement, and distress. *Personal. Individ. Differ.* 43, 2182–2192. doi: 10.1016/j.paid.2007.06.036u

Stoeber, J., and Otto, K. (2006). Positive conceptions of perfectionism: approaches, evidence, challenges. *Personal. Soc. Psychol. Rev.* 10, 295–319. doi: 10.1207/s15327957pspr1004_2

Studer, R. K., Danuser, B., Wild, P., Hildebrandt, H., and Gomez, P. (2014). Psychophysiological activation during preparation, performance, and recovery in high- and low-anxious music students. *Appl. Psychophysiol. Biofeedback* 39, 45–57. doi: 10.1007/s10484-014-9240-2

Studer, R., Gomez, P., Hildebrandt, H., Arial, M., and Danuser, B. (2011). Stage fright: its experience as a problem and coping with it. *Int. Arch. Occup. Environ. Health* 84, 761–771. doi: 10.1007/s00420-010-0608-1

Sweeney, G. A., and Horan, J. J. (1982). Separate and combined effects of cue-controlled relaxation and cognitive restructuring in the treatment of musical performance anxiety. *J. Couns. Psychol.* 29, 486–497. doi: 10.1037/0022-0167.29.5.486

Syme, K. L., and Hagen, E. H. (2020). Mental health is biological health: why tackling "diseases of the mind" is an imperative for biological anthropology in the 21st century. *Am. J. Phys. Anthropol.* 171, 87–117. doi: 10.1002/ajpa.23965

Talbot-Honeck, C. (1994). *Excellence in the performing arts: A study of elite musicians' mental readiness to perform*. Ottawa: University of Ottawa.

Tang, Y., and Ryan, L. (2020). Music performance anxiety: can expressive writing intervention help? *Front. Psychol.* 11:1334. doi: 10.3389/fpsyg.2020.01334

Thomas, J. P., and Nettelbeck, T. (2014). Performance anxiety in adolescent musicians. *Psychol. Music* 42, 624–634. doi: 10.1177/0305735613485151

Thurber, M. R., Bodenhamer-Davis, E., Johnson, M. L., Chesky, K., and Chandler, C. K. (2010). Effects of heart rate variability coherence biofeedback training and emotional management techniques to decrease music performance anxiety. *Biofeedback* 38, 28–40. doi: 10.5298/1081-5937-38.1.28

Tomlinson, C. (2018). *Music from the inside out*. Market Harborough: Troubador Publishing Ltd.

Topoğlu, O., Karagülle, D., Keskin, T., Abacigil, F., and Okyay, P. (2018). General health status, music performance anxiety, and coping methods of musicians working in Turkish state symphony orchestras: A cross-sectional study. *Med. Probl. Perform. Art.* 33, 118–123. doi: 10.21091/mppa.2018.2019

Tremayne, P., and Morgan, A. (2016). "Attention, centering, and being mindful: medical specialties to the performing arts" in *Mindfulness and performance*. ed. A. L. Baltzell (Cambridge: Cambridge University Press), 389–411.

Turan, B., Hurst-Wajszczuk, K., and Edwards, D. A. (2022). Hormone and enzyme reactivity before, during, and after a music performance: cortisol, testosterone, and alpha-amylase. *Comprehens. Psychoneuroendocrinol.* 9:100111. doi: 10.1016/j.cpnec.2022.100111

Turner, S. M., Beidel, D. C., Dancu, C. V., and Stanley, M. A. (1989). An empirically derived inventory to measure social fears and anxiety: the social phobia and anxiety inventory. *Psychol. Assess.* 1, 35–40. doi: 10.1037/1040-3590.1.1.35

Valentine, E. R. (2002). "The fear of performance. In musical performance: A guide to understanding" in *Musical performance: A guide to understanding*. ed. J. Rink (Cambridge: Cambridge University Press), 168–182.

Valentine, E. R., Fitzgerald, D. F., Gorton, T. L., Hudson, J. A., and Symonds, E. R. (1995). The effect of lessons in the Alexander technique on music performance in high and low stress situations. *Psychol. Music* 23, 129–141. doi: 10.1177/0305735695232002

Van Fenema, E., Julsing, J. E., Carlier, I. V., van Noorden, M. S., Giltay, E. J., van der Wee, N. J., et al. (2013). Musicians seeking psychiatric help: A preliminary study of psychiatric characteristics. *Med. Probl. Perform. Art.* 28, 9–18. doi: 10.21091/mppa.2013.1003

Van Kemenade, J. F., Van Son, M. J., and Van Heesch, N. C. (1995). Performance anxiety among professional musicians in symphonic orchestras: A self-report study. *Psychol. Rep.* 77, 555–562. doi: 10.2466/pr0.1995.77.2.555

Van McKinney, H. (1984). *The effects of thermal biofeedback training on musical performance and performance anxiety [PhD Thesis]*. Greeley, CO: University of Northern Colorado, School of Music.

Vervainioti, A., and Alexopoulos, E. C. (2015). Job-related stressors of classical instrumental musicians: A systematic qualitative review. *Med. Probl. Perform. Art.* 30, 197–202. doi: 10.21091/mppa.2015.4037

Vivas, E., Nascimento, M., and Rocha, S. (2021). The performance anxiety influence on the motor coordination levels: A literature mini-review. *Int. J. Educ. Res.* 3, 1–5.

Voltmer, E., Zander, M., Fischer, J. E., Kudielka, B. M., Richter, B., and Spahn, C. (2012). Physical and mental health of different types of orchestra musicians compared to other professions. *Med. Probl. Perform. Art.* 27, 9–14. doi: 10.21091/mppa.2012.1003

Walsh, R. (1995). Phenomenological mapping: A method for describing and comparing states of consciousness. *J. Transpers. Psychol.* 27:25.

Walton, C. C., Osborne, M. S., Gilbert, P., and Kirby, J. (2022). Nurturing self-compassionate performers. *Aust. Psychol.* 57, 77–85. doi: 10.1080/00050067.2022.2033952

Wardle, A. (1969). *Behavioral modification by reciprocal inhibition of instrumental music performance anxiety [Doctoral thesis]*. Tallahassee, FL: Florida State University.

Wells, R., Outhred, T., Heathers, J. A. J., Quintana, D. S., and Kemp, A. H. (2012). Matter over mind: A randomised-controlled trial of single-session biofeedback. *PLoS One* 7:e46597. doi: 10.1371/journal.pone.0046597

Wesner, R. B., Noyes, R. Jr., and Davis, T. L. (1990). The occurence of performance anxiety among musicians. *J. Affect. Disord.* 18, 177–185. doi: 10.1016/0165-0327(90)90034-6

WHO. (2004). *Management of mental disorders (treatment protocol project, Vol. 1)*. Darlinghurst, NSW: World Health Organization collaborating Centre for Evidence in mental health policy (secondary source, cited in Osborne & Kirsner, 2022).

Wiedemann, A., Vogel, D., Voss, C., and Hoyer, J. (2021). How does music performance anxiety relate to other anxiety disorders? *Psychol. Music* 50, 204–217. doi: 10.1177/0305735620988600

Wiedemann, A., Vogel, D., Voss, C., Nusseck, M., and Hoyer, J. (2020). The role of retrospectively perceived parenting style and adult attachment behaviour in music performance anxiety. *Psychol. Music* 48, 707–723. doi: 10.1177/0305735618817877

Williamon, A. (2004). *Musical excellence: Strategies and techniques to enhance performance*. Oxford: Oxford University Press.

Williamon, A., Aufegger, L., Wasley, D., Looney, D., and Mandic, D. P. (2013). Complexity of physiological responses decreases in high-stress musical performance. *J. R. Soc. Interface* 10:20130719. doi: 10.1098/rsif.2013.0719

Wilson, G. D. (1994). *Psychology for performing artists: Butterflies and bouquets*. London: Jessica Kingsley.

Wolfe, M. L. (1989). Correlates of adaptive and maladaptive musical performance anxiety. *Med. Probl. Perform. Art.* 4, 49–56.

Wolfe, M. L. (1990). Coping with musical performance anxiety: problem-focused and emotion-focused strategies. *Med. Probl. Perform. Art.* 5, 33–36.

Yadigaroğlu, Z. (2021). Examination of music performance anxiety of music teacher candidates. *Int. J. Educ. Technol. Scient. Res.* 6, 2064–2104. doi: 10.35826/ijetsar.398

Yang, Y., Schroeder, F., and Rodger, M. (2022). "The role of perfectionism in music performance anxiety within university piano majors in China" in *Advances in design, music and arts II*. eds. D. Raposo, J. Neves, R. Silva, L. Correia Castilho and R. Dias (New York: Springer International Publishing), 674–689.

Yerkes, R. M., and Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *J. Comp. Neurol. Psychol.* 18, 459–482. doi: 10.1002/cne.920180503

Yoshie, M., Kudo, K., Murakoshi, T., and Ohtsuki, T. (2009). Music performance anxiety in skilled pianists: effects of social-evaluative performance situation on subjective, autonomic, and electromyographic reactions. *Exp. Brain Res.* 199, 117–126. doi: 10.1007/s00221-009-1979-y

Zakaria, J. B., Musib, H. B., and Shariff, S. M. (2013). Overcoming performance anxiety among music undergraduates. *Procedia. Soc. Behav. Sci.* 90, 226–234. doi: 10.1016/j.sbspro.2013.07.086

Zhukov, K. (2019). Current approaches for Management of Music Performance Anxiety: an introductory overview. *Med. Probl. Perform. Art.* 34, 53–60. doi: 10.21091/mppa.2019.1008

Zinn, M., McCain, C., and Zinn, M. (2000). Musical performance anxiety and the high-risk model of threat perception. *Med. Probl. Perform. Art.* 15, 65–71. doi: 10.21091/mppa.2000.2013

Zyl, M. (2021). The effects of virtual reality on music performance anxiety among university-level music majors. *Visions Res. Music Educ.* 35

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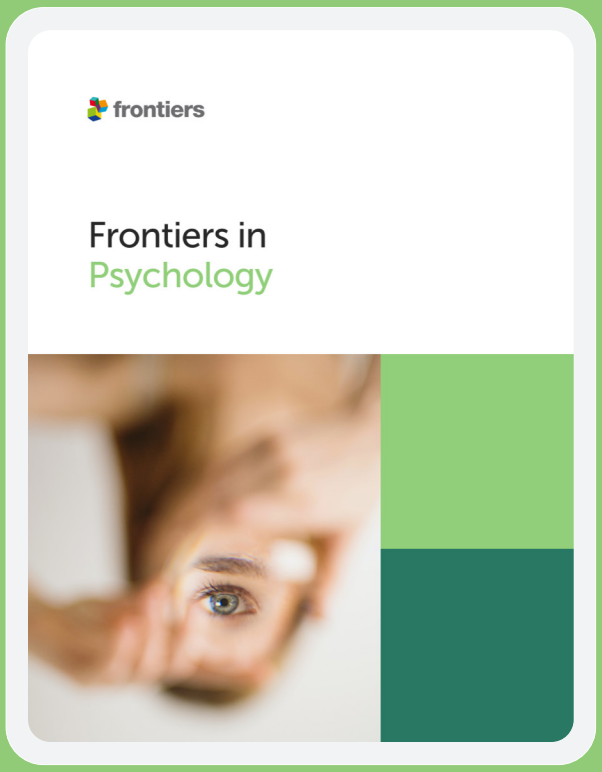

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